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

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Division RS III 3
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List of Abbreviations

ALG	*Abfalllager Gorleben* (Gorleben Interim Waste Storage Facility)
AKR	*Ausbildungskernreaktor* (Training Reactor)
AREVA NC	AREVA Nuclear Cycle (formerly COGEMA)
AtAV	*Atomrechtliche Abfallverbringungsverordnung* (Nuclear Waste Shipment Ordinance)
AtG	*Atomgesetz* (Atomic Energy Act)
AtSMV	*Atomrechtliche Sicherheitsbeauftragten- und Meldeverordnung* (Nuclear Safety Officer and Reporting Ordinance)
AtVfV	*Atomrechtliche Verfahrensverordnung* (Nuclear Licencing Procedure Ordinance)
AtZüV	*Atomrechtliche Zuverlässigkeitsüberprüfungsverordnung* (Nuclear Reliability Assessment Ordinance)
AVK	*Abfallfluss-, Verfolgungs- und Produkt-Kontrollsystem* (Waste Flow Tracking and Product Control System)
AVR	*Arbeitsgemeinschaft Versuchsreaktor GmbH* (Experimental nuclear power plant at Jülich)
AVV	*Allgemeine Verwaltungsvorschrift* (General Administrative Regulation)
BAFA	*Bundesamt für Wirtschaft und Ausfuhrkontrolle* (Federal Office of Economics and Export Control)
BAM	*Bundesanstalt für Materialforschung und –prüfung* (Federal Institute for Materials Research and Testing)
BBC	Brown, Boveri & Cie
BBK	Brown Boveri/Krupp Reaktorbau GmbH
BfS	*Bundesamt für Strahlenschutz* (Federal Office for Radiation Protection)
BGBl.	*Bundesgesetzblatt* (Federal Law Gazette)
BLG	*Brennelement-Lager Gorleben* (Fuel assembly storage facility at Gorleben)
BMBF	*Bundesministerium für Bildung und Forschung* (Federal Ministry of Education and Research)
BMU	*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit* (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)
BNFL	British Nuclear Fuels Ltd.
BVerwG	*Bundesverwaltungsgericht* (Federal Administrative Court)
BWR	Boiling Water Reactor
BZA	*Brennelement-Zwischenlager Ahaus GmbH* (Fuel assembly storage facility at Ahaus)
CEA	Commissariat à l'Energie Atomique (Paris)
COGEMA	Compagnie Générale des Matières Nucléaires

CSD-C	*Colis Standard de Déchets Compactés* (Radioactive waste compacted under high pressure)
DBE	*Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH* (German Service Company for the Construction and Operation of Waste Repositories)
DESY	*Deutsches Elektronen-Synchrotron* (German Electron Synchroton at Hamburg)
DIN	*Deutsches Institut für Normung e. V.* (German Institute for Standardisation)
EAN	European Article Numbering
EBA	*Eisenbahn-Bundesamt* (Federal Office for Railways)
EIA	Environmental Impact Assessment
ENSTTI	European Nuclear Safety Training and Tutoring Institute
ERAM	*Endlager für radioaktive Abfälle Morsleben* (Repository for Radioactive Waste Morsleben)
ESK	*Entsorgungskommission* (Waste Management Commission)
ETSON	European TSO Network
EURATOM	European Atomic Energy Community
EUROCHEMIC	European Company for the Chemical Processing of Irradiated Fuels
EU	European Union
EVU	*Energieversorgungsunternehmen* (Electric Power Utility)
EW	Exempt waste
EWN	*Energiewerke Nord GmbH* (Energy Utility North)
FH	*Fachhochschule* (University of Applied Sciences)
FR-2	*Forschungsreaktor 2, Karlsruhe* (Research Reactor 2, Karlsruhe
FRG	*Forschungsreaktor Geesthacht* (Research reactor Geesthacht)
FRJ	*Forschungsreaktor Jülich* (Research reactor Jülich)
FRM	*Forschungsreaktor München, Garching* (Research reactor Munich, Garching)
FRMZ	*Forschungsreaktor Mainz* (Research reactor Mainz)
FZD	*Forschungszentrum Dresden-Rossendorf e.V* (Research Centre Dresden-Rossendorf)
FZJ	*Forschungszentrum Jülich GmbH* (Research Centre Jülich GmbH)
FZK	*Forschungszentrum Karlsruhe GmbH* (Research Centre Karlsruhe GmbH)
GDR	German Democratic Republic
GKSS	*Forschungszentrum Geesthacht GmbH* (formerly*: Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt mbH)* (Research Centre Geesthacht GmbH)
GNS	*Gesellschaft für Nuklear-Service mbH*
GorlebenVSpV	*Gorleben-Veränderungssperren-Verordnung* (Gorleben Development Freeze Ordinance)

GRB	*Sammelstelle Bayern für radioaktive Stoffe GmbH* (Bavarian collecting facility for radioactive substances)
GRS	*Gesellschaft für Anlagen- und Reaktorsicherheit mbH*
GSF	*Gesellschaft für Strahlenforschung* (now: HMGU)
GSI	*Gesellschaft für Schwerionenforschung mbH*
GSF	*Helmholtz Zentrum München - Deutsches Forschungszentrum für Gesundheit und Umwelt GmbH (*formerly: *Gesellschaft für Strahlenforschung)* (Helmholtz Zentrum München – German Research Centre for Environmental Health GmbH)
HASS	High-activity sealed radioactive sources
HAW	High Active Waste
HAWC	High Active Waste Concentrate
HDB	*Hauptabteilung Dekontaminationsbetriebe des Forschungszentrums Karlsruhe* (Central Decontamination Department of the Karlsruhe Research Centre)
HDR	*Heißdampfreaktor, Großwelzheim* (Superheated Steam Reactor, Großwelzheim)
HEU	Highly Enriched Uranium
HGF	*Hermann von Helmholtz-Gemeinschaft Deutscher Forschungszentren*
HKG	*Hochtemperatur-Kernkraftwerk GmbH*
HLW	High-level waste
HM	Heavy Metal
HMGU	*Helmholtz Zentrum München – Deutsches Forschungszentrum für Gesundheit und Umwelt GmbH* (formerly: GSF)
HMI	*Hahn-Meitner-Institut für Kernforschung*
HTR	*Hochtemperaturreaktor* (High Temperature Reactor)
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IEC	International Electrotechnical Commission
ILW	Intermediate-level waste
IMIS	*Integriertes Mess- und Informationssystem zur Überwachung der Umweltradioaktivität* (Integrated Measurement and Information System for Monitoring Environmental Radioactivity)
INES	International Nuclear Event Scale
INEX	International Nuclear Emergency Exercise
ISO	International Organisation for Standardisation
ITU	*Europäisches Institut für Transurane, Karlsruhe* (European Institute for Transuranic Elements, Karlsruhe)
KFA	*Kernforschungsanlage Jülich* (now: FZJ)
KfK	*Kernforschungszentrum Karlsruhe* (now: FZK)
KGR	*Kernkraftwerk Greifswald* (Greifswald Nuclear Power Plant)
KIT	*Karlsruher Institut für Technologie* (Karlsruhe Institute of Technology)
KKN	*Kernkraftwerk Niederaichbach* (Niederaichbach Nuclear Power Plant)
KKR	*Kernkraftwerk Rheinsberg* (Rheinsberg Nuclear Power Plant)
KKS	*Kernkraftwerk Stade* (Stade Nuclear Power Plant)
KMK	*Kernkraftwerk Mühlheim-Kärlich* (Mühlheim-Kärlich Nuclear Power Plant)

KNK II	*Kompakte Natriumgekühlte Kernreaktoranlage, Karlsruhe* (Compact sodium-cooled nuclear reactor plant, Karlsruhe)
KRB	*Kernkraftwerk Gundremmingen* (Gundremmingen Nuclear Power Plant)
KTA	*Kerntechnischer Ausschuss* (Nuclear Safety Standards Commission)
KWL	*Kernkraftwerk Lingen* (Lingen Nuclear Power Plant)
KWO	*Kernkraftwerk Obrigheim* (Obrigheim Nuclear Power Plant)
KWU	*Kraftwerk Union AG*
KWW	*Kernkraftwerk Würgassen* (Würgassen Nuclear Power Plant)
LAA	*Länderausschuss für Atomkernenergie* (*Länder* (Federal States) Committee on Nuclear Power)
LAVA	*Lagerungs- und Verdampfungsanlage in der Wiederaufarbeitungsanlage Karlsruhe* (Storage and evaporation facility at the Karlsruhe reprocessing plant)
LAW	Low Active Waste
LBA	*Luftfahrtbundesamt* (Federal Civil Aviation Authority)
LLW	Low-level waste
LWR	Light Water Reactor
MAW	Medium Active Waste
Mg HM	10^6 g (1 metric ton) heavy metal
MLU	*Ministerium für Landwirtschaft und Umwelt* (Ministry of Agriculture and the Environment)
MOX	Mixed oxide
MTR	*Materialtestreaktor* (Material testing reactor)
MZFR	*Mehrzweckforschungsreaktor, Karlsruhe* (Multi-purpose research reactor, Karlsruhe)
NCS	Nuclear Cargo + Service GmbH
NDA	Nuclear Decommissioning Authority
NEA	Nuclear Energy Agency
NORM	Naturally Occurring Radioactive Material
NPP	Nuclear Power Plant
ODL	*Gamma-Ortsdosisleistung* (Gamma dose rate)
OECD	Organisation for Economic Co-operation and Development
PAE	*Projektgruppe Andere Entsorgungstechniken des Forschungszentrum Karlsruhe* (Project Group for Alternative Waste Management Techniques, Karlsruhe Research Centre)
PFB	*Planfeststellungsbeschluss* (Plan approval notice)
PKA	*Pilot-Konditionierungsanlage, Gorleben* (Pilot Conditioning Plant, Gorleben)
PSR	Periodic Safety Review
PUREX	Plutonium-Uranium Recovery by Extraction
PWR	Pressurised Water Reactor
REI	*Richtlinie zur Emissions- und Immissionsüberwachung kerntechnischer Anlagen* (Guideline concerning Emission and Immission Monitoring of Nuclear Installations)

ReVK	*Reststofffluss-Verfolgungs- und Kontrollsystem* (Software system for the documentation, methodical tracking and management of radioactive materials and waste)
RFR	*Rossendorfer Forschungsreaktor* (Rossendorf research reactor)
RöV	*Röntgenverordnung* (X-Ray Ordinance)
RPV	Reactor pressure vessel
RSK	*Reaktorsicherheitskommission* (Reactor Safety Commission)
RWTH	*Rheinisch-Westfälische Technische Hochschule Aachen*
SKB	Svensk Kärnbränslehantering AB (Swedish Nuclear Fuel and Waste Management Co)
SSK	*Strahlenschutzkommission* (Commission on Radiological Protection)
STEAG	*Steinkohlen-Elektrizität AG*
StrlSchV	*Strahlenschutzverordnung* (Radiation Protection Ordinance)
StrVG	*Strahlenschutzvorsorgegesetz* (Precautionary Radiation Protection Act)
SUR	*Siemens Unterrichtsreaktor* (Siemens research reactor designed for training purposes)
SZL	*Standortzwischenlager* (On-site interim storage facility)
TBL	*Transportbehälterlager* (Transport Cask Storage Facility)
TBL-A	*Transportbehälterlager Ahaus* (Transport Cask Storage Ahaus)
TBL-G	*Transportbehälterlager Gorleben* (Transport Cask Storage Gorleben)
TH	*Technische Hochschule* (Technical University)
THTR	*Thorium-Hochtemperaturreaktor, Hamm-Uentrop* (Thorium High-Temperature Reactor, Hamm-Uentrop)
TRIGA	Training, Research and Isotope Production Facility of General Atomic (Reactor)
TSO	Technical Safety Organisation
TU	*Technische Universität* (Technical University)
UKAEA	United Kingdom Atomic Energy Agency
UVPG	*Umweltverträglichkeitsprüfungsgesetz* (Environmental Impact Assessment Act)
VAK	*Versuchsatomkraftwerk Kahl* (Experimental nuclear power plant, Kahl)
VBA	*Verlorene Betonabschirmungen* (Lost concrete shieldings)
VEK	*Verglasungseinrichtung Karlsruhe* (Karlsruhe vitrification plant)
VKTA	*Verein für Kernverfahrenstechnik und Analytik Rossendorf e. V.* (Nuclear Engineering and Analytics Rossendorf Inc.)
VLLW	Very-low-level waste
VSLW	Very-short-lived waste
WAK	*Wiederaufbereitungsanlage Karlsruhe* (Karlsruhe reprocessing plant)

WENRA	Western European Nuclear Regulators' Association
WGWD	WENRA Working Group on Waste and Decommissioning
WTI	*Wissenschaftlich-Technische Ingenieurberatung GmbH*
WWER	Water-cooled and water-moderated energy reactor (Soviet design)
ZAB	*Zwischenlager für abgebrannten Brennstoff, Greifswald* (Interim storage facility for spent fuel, Greifswald)
ZAW	*Zentrale Aktive Werkstatt, Greifswald* (Central active workshop, Greifswald)
ZfK	*Zentralinstitut für Kernforschung, Rossendorf* (Central Institute for Nuclear Research, Rossendorf)
ZLN	*Zwischenlager Nord, Greifswald* (Interim Storage Facility "*Zwischenlager Nord*", Greifswald)

Summary

Status of power and research reactors in Germany

There are currently nine power reactors in operation in Germany. These are exclusively light-water reactors (seven pressurised water reactors and two boiling water reactors whose fuel assemblies are composed of low-enriched uranium oxide or uranium/plutonium mixed oxide (MOX)). With the 13th amendment to the Atomic Energy Act of 6 August 2011 as a consequence of the events in Japan, which led to a reassessment of the risks associated with the use of nuclear energy, the licences to operate the Biblis A and B, Neckarwestheim 1, Brunsbüttel, Isar 1, Unterweser, Philippsburg 1 and Krümmel plants expired. For the remaining nine nuclear power plants, the operating licences will expire between 2015 and the end of 2022. Another 12 power reactors have already been or are in the process of being decommissioned.

There were furthermore seven prototype and demonstration nuclear power plants operated in Germany, which have all been decommissioned. Two of these, the HDR Großwelzheim, which was fully removed in 1998, and the VAK Kahl, which was also removed completely in 2010, were boiling water reactors using low-enriched uranium oxide pellets (in the VAK partly also MOX) as fuel. Two other reactors, the AVR at Jülich and the THTR at Hamm-Uentrop, were helium-cooled graphite-moderate high-temperature reactors in which the medium- and high-enriched fuel consisting of uranium/thorium oxide particles was enclosed in graphite spheres. The MZFR at Karlsruhe was a heavy-water reactor using very-low-enriched (0.85 %) uranium oxide fuel. The Compact Sodium-Cooled Nuclear Reactor (*Kompakter Natriumgekühlter Kernreaktor* – KNK II) at Karlsruhe used high-enriched uranium oxide and uranium/plutonium mixed-oxide fuel. The Niederaichbach NPP (KKN) was in operation between 1972 and 1974 as a prototype plant with a heavy-water-moderated and CO_2-gas-cooled pressure tube reactor using natural uranium as fuel. Its complete removal was finished in 1995; the reactor was released from regulatory supervision.

There are at present three research reactors (MTR facility BER-II at Berlin; high-flux reactor FRM II at Garching; TRIGA reactor at Mainz), three teaching reactors and one training reactor in operation in Germany.

Spent fuel management facilities

Facilities for the management of spent fuel in terms of this Convention are:

- the interim storage facilities at the nuclear power plant sites,
- the central interim storage facilities at Gorleben (TBL-G) and Ahaus (TBL-A),
- the interim storage facility "*Zwischenlager Nord*" (ZLN) near Greifswald for the spent fuel from the Rheinsberg and Greifswald nuclear power plants as well as the interim storage facility at Jülich for the spent fuel of the AVR reactor,
- the pilot conditioning plant at Gorleben (PKA).

(1) On-site interim storage facilities

At twelve nuclear power plant sites, decentralised interim storage facilities for spent fuel have been licenced under atomic law, constructed and commissioned. They are designed as dry storage facilities in which transport and storage casks loaded with spent fuel are emplaced.

The interim storage facilities are cooled by passive air convection which removes the heat from the casks without any active technical systems. The leak-tight 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 licencing procedure that the casks are suitable for at least 40 years of storage; the licences limit the storage period correspondingly (starting with the emplacement of the first cask). A prolonging of the storage requires an authorisation.

(2) Interim storage facilities at Gorleben and Ahaus

Central storage facilities containing fuel assemblies from various German nuclear power plants have been licenced at Gorleben and Ahaus. Both facilities are designed as dry storage facilities. The Ahaus facility is additionally licenced for storage of transport and storage casks of the types CASTOR® THTR/AVR (in all 305 casks) und MTR 2 (in all 18 casks).

It is intended to use the Ahaus interim storage facility if necessary for the storage of further fuel assemblies from the three operating research reactors BER-II, FRM II and FRMZ in casks of the type CASTOR® MTR 2. No decision about this possibility has yet been made as it is intended to repatriate the fuel assemblies from BER-II and FRMZ as well as from the already shut-down MTR facilities at Geesthacht and Jülich in the USA. For the FRM II, the road to the USA is not open. The fuel assemblies are therefore also to be put in interim storage at Ahaus with a view to their disposal in a repository. The modification of the FRM II to use lower enriched uranium instead of high-enriched uranium (93 % U-235) is intended for 2018. In addition, the spent fuel from the decommissioned research reactor at Rossendorf is also stored at Ahaus.

In September 2009, the Transport Cask Storage Facility Ahaus and the *Gesellschaft für Nuklear-Service mbH* applied for the storage of nuclear fuels in form of spent fuel of the former research reactor AVR GmbH Jülich in a total of 152 transport and storage casks of the type CASTOR® THTR/AVR in the Ahaus interim storage facility. Furthermore they applied for the storage of high-pressure-compacted radioactive waste (the so called CSD-C resulting from reprocessing at La Hague) in transport and storage casks of the TGC36 type.

In November 2009, the licence according to § 7 of the Radiation Protection Ordinance (StrlSchV) [1A-8] for the interim storage of low and intermediate level waste at Ahaus was granted. The storage period is limited to 10 years. On 21 July 2010, first waste packages were emplaced.

The interim storage facility at Gorleben is additionally licenced for the storage of vitrified HAW glass canisters. In January 2010, a licence for the storage of casks of the type CASTOR® HAW 28M was granted. By the end of the year, there were a total of 97 casks with vitrified waste. The storage of other conditioned radioactive materials in waste packages in separate areas of the interim storage facility is in preparation.

(3) Interim Storage Facility "*Zwischenlager Nord*" (ZLN) at Greifswald and interim storage facility at Jülich

In the interim storage facility "*Zwischenlager Nord*" (ZLN) at Greifswald, spent fuel from the Soviet-type reactors at Rheinsberg and Greifswald that were shut down in 1990 is stored.

The facility furthermore accommodates spent and fresh fuel from the Compact Sodium-cooled Nuclear Reactor Plant (KNK II) and from the Nuclear Ship Otto Hahn. The four transport and storage casks of the type CASTOR® KNK were taken back from France and emplaced in the ZLN in December 2010. The ZLN is also licenced to store vitrified waste from the Karlsruhe vitrification plant (VEK). By the end of 2010, the about 60 m³ of HAWC solution that had been generated during the operation of the Karlsruhe reprocessing plant (WAK) had been vitrified in 140 stainless-steel canister at the VEK. These canisters were then placed in five CASTOR® HAW 20/28 CG transport and storage casks and shipped to the ZLN in February 2011.

The interim storage facility at Jülich, licenced until 30 June 2013, contains the spent fuel spheres from the operation of the experimental nuclear power plant at Jülich (AVR). The interim storage facility is to be closed and the 152 stored transport and storage casks of the type CASTOR® THTR/AVR are to be transferred into the interim storage facility at Ahaus.

(4) Gorleben pilot conditioning plant (PKA)

The reference concept for disposal of spent fuel envisages the removing the fuel rods from the fuel assemblies in an aboveground plant, the packaging of the fuel rods in self-shielding and sealed thick-walled casks and emplacing them in deep geological formations for disposal. In order to demonstrate the conditioning technique, a pilot conditioning plant (PKA) was constructed at Gorleben in the year 2000. The plant is licenced for a throughput of 35 Mg HM/a. Pursuant to the agreement between the Federal Government and the utilities of 11 June 2001, the licencing procedure is complete, but use of the facility is licenced only for the repair of damaged casks for spent fuel from light-water reactors and for vitrified HAW from reprocessing as well as for the handling of other radioactive materials. As a prerequisite for the pilot operating start the licence requires the naming of a repository site and the qualification of the conditioning procedure.

Spent fuel management policy and practices

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. 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 direct disposal. Since 1 July 2005, delivery of spent fuel 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 2002. Now, only the direct disposal of the spent fuel existing and being generated in future in Germany is permissible.

For the spent fuel which until 30 June 2005 was delivered for reprocessing to France and the United Kingdom, proof of re-use must be furnished by the licencees of the non-hazardous re-use of the 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 and thus re-used.

The remaining and in future generated spent fuel in Germany will be stored intermediately at the sites where it was generated until such time as a repository is commissioned. An application to construct an interim storage facility for the dry storage of fuel assemblies has been submitted for the Obrigheim nuclear power plant under decommissioning, where a wet storage facility is presently in operation.

As there is yet no repository available for the spent fuel, it will be stored intermediately at the sites where it was generated; corresponding storage facilities exist as needed. Usually, the spent fuel from research reactors will be returned to its country of origin. If this is not possible, these too will be intermediately stored until their final transportation to the repository.

There are conceptual considerations regarding the design of a repository. The concept of direct disposal provides that following interim storage of several decades, spent fuel will be packed into containers suitable for disposal and that these will be sealed leak-tight and emplaced in drifts or boreholes in deep geological formations. The prototype of a facility for packaging spent fuel in containers suitable for disposal has been built. The aim is to commission a repository around the year 2035.

In Germany, a total of 13 471 Mg HM in the form of irradiated fuel assemblies have been generated by the end of 2010. Of these, a total of 6 801 Mg HM are in local storage at the NPP sites, i.e. in the fuel pools, or in the centralised or decentralised interim storage facilities; 6 343 Mg HM were reprocessed mostly in other European countries, and 327 Mg HM were otherwise disposed of.

Radioactive waste management policy and 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 waste generators.

In addition to German facilities, facilities in other European foreign countries are also utilised for waste management. Radioactive waste generated from the operation of nuclear installations is delivered to Sweden for conditioning and subsequently returned to Germany. Waste from the reprocessing of spent fuel from German power reactors is conditioned in France and the United Kingdom (e.g. vitrification of the high-level fission product solutions) 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 generated from the use and handling of radioisotopes in research, industry and medicine, *Land* collecting facilities operated by the *Länder* are available for interim storage.

For the interim storage of heat-generating radioactive waste, decentral and central interim storage facilities are available as well; the waste from the reprocessing of spent fuel of German utilities in France and the UK is stored at two centralised storage facilities at Gorleben and Ahaus. In addition, heat-generating radioactive waste is stored at research institutions and, to a low extent, also in *Land* collecting facilities.

Compliance with the waste acceptance requirements is verified within the scope of the product control procedure. Here, the waste acceptance requirements for disposal as they apply to the licenced Konrad repository, which is currently under construction, are the relevant criteria. The product control measures refer to already conditioned waste as well as to radioactive waste to be conditioned in future. They are devised such that a reliable detection of waste packages that are not in compliance with the specifications is ensured.

In Germany, a total of 96 513 m³ of conditioned waste with negligible heat generation were in storage at the end of 2010, stemming mainly from research institutions, nuclear power plants and the nuclear industry, including reprocessing, as well as from the medical sector and other industries. As for heat-generating, conditioned radioactive waste, a total of 673 m³ of mainly vitrified high-active waste from reprocessing as well as 1 252 m³ of interim products from decommissioned nuclear power plants (irradiated fuel spheres from the Hamm-Uentrop nuclear power plant) are in storage. Between 1967 and 1978, a total of 124 494 waste packages holding low-active waste were emplaced in the Asse II mine, partly with so-called “lost concrete shieldings” with higher activities, and 1 293 drums holding medium-active waste were also emplaced. In the Morsleben repository for low-level and medium-level radioactive waste (ERAM), some 36 753 m^3 of solid waste with comparatively low concentrations of alpha emitters and 6 617 sealed radiation sources were emplaced.

Classification of radioactive waste

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 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, as well as 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.

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.

Heat-generating radioactive waste is characterised by high activity concentrations and therefore by high decay heat output; this waste includes in particular the fission product concentrate, hulls, structural components and feed sludge from the reprocessing of spent fuel assemblies, and the spent fuel itself if there are no plans to reprocess it but instead to dispose it of as radioactive waste. All heat-generating waste from the reprocessing of German LWR spent fuel at La Hague and Sellafield is vitrified and filled into canisters (gross volume 180 litres, filling quantity 150 litres).

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 and contaminated tools, protective clothing, decontamination and cleaning agents, laboratory waste, sealed radiation sources, sludges, suspensions and oils.

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 a distinction is strictly made between different waste producers. Cast-iron containers, concrete containers or box-shaped containers are predominantly used for packaging radioactive waste, whilst glass and cement/concrete are widely used for the purposes of immobilisation. 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 generated in the foreseeable future.

Responsibilities in the area of spent fuel and radioactive waste management

The management of spent fuel and radioactive waste is based on the polluter-pays principle. According to § 9a, para. 1 AtG [1A-3], 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 and the radioactive waste.

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. 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. 3 AtG, the *Länder* are required to establish *Land* collecting facilities for the storage of radioactive waste generated within their territory. The producers of radioactive waste generated from the use of nuclear energy are responsible for its interim storage and conditioning.

According to § 9a, para. 3 AtG, the Federation 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 the compliance with the legal requirements and the requirements stipulated in the licence. 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 licenced by the BfS.

Funding of spent fuel and radioactive waste management

The polluter-pays principle also applies to the funding of the disposal of spent fuel and radioactive waste. Regarding the disposal of spent fuel and radioactive waste and for the actual decommissioning of nuclear installations, the respective private operators are obligated to build up sufficient financial reserves. The public operators set aside the corresponding funds for dismantling and decommissioning in their respective current budgets.

The necessary expenditures of those obliged to hand over the waste to plan and construct a repository are refinanced by the Federation via advance payments on contributions. The use of repositories and *Land* collecting agencies is refinanced via charges and fees that the delivering parties have to pay.

As the continued monitoring of a repository after its closure is a federal task, the funds necessary for this purpose are provided by the Federation.

Legislative and regulatory framework in the area of spent fuel and radioactive waste management

The Federal Republic of Germany is a Federal State. The 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 of the Federal Republic of Germany.

The legislative competence for the use of nuclear energy for peaceful purposes lies with the Federal Government. The further development of nuclear law is also a task of the Federal Government. The *Länder* will be involved in the procedure dependent on the subject matter.

The Atomic Energy and the statutory ordinances based thereon are implemented by authorities of the Federation and the *Länder*, with many tasks related to the execution performed 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 oversight by the Federal Government.

Assurance of the safe handling of disused sealed sources

Nearly 100 000 of sealed sources are used in research, trade, industry, medicine and agriculture in Germany. The most common fields of application for sealed sources in industry are the calibration of measuring devices, materials testing, exposure and sterilisation of products, as well as level and density measurement. In medicine, the sealed sources are mostly used for radiotherapy and for the irradiation of blood. The radionuclides in sealed sources are mostly Co-60, Ir-192, Cs-137, Sr-90 and Am-241 whose activity reaches some kBq for test and calibration emitter and some TBq of radioactive sources for irradiation facilities. In Germany, the safety of disused sealed sources is ensured by a legal framework in accordance with European and international legal standards and by an extensive system of licencing and supervision. In the majority of the very rare cases of lost or found 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.

Re-entry of disused sealed sources

According to § 69, para. 5 StrlSchV [1A-8], 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 licencee or have to be handed over 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 managed without precautionary measures. 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 sources may only be returned to Germany as other radioactive material if the delivery is exclusively to the manufacturer of supplier who fulfils the above-mentioned requirements or if the recipient can demonstrate that he will either continue to use them as licenced radiation sources or recycle them.

Shipment within the EU is not subject to licencing requirements. Transboundary shipment within the EU is regulated by Directive 1493/93/EURATOM [EUR 93]. 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 licencing or notification, e.g. for re-entry of a radiation source from a non-EU country, the competent authority according to § 22 AtG [1A-3] is the BAFA.

Main developments in Germany since the Third Review Meeting

With the amendment of the AtG of 17 March 2009 it was stipulated that for the operation and closure of the Asse II mine in the future the provisions of the Atomic Energy Act on repositories of the Federation shall apply (§§ 23 and 57b AtG [1A-3]). The Federal Office for Radiation Protection as a new operator will be both responsible for the closure of the Asse II mine in the context of a nuclear plan approval procedure in accordance with § 9b AtG and for continued operation of the installations until its closure; the continued operation does not require the performance of a plan approval procedure.

The 11th amendment to the Atomic Energy Act of 8 December 2010 extended the operating life of the nuclear power plants in operation at that time by an average of twelve years. With the 13th amendment to the Atomic Energy Act of 6 August 2011 as a consequence of the events in Japan, which led to a reassessment of the risks associated with the use of nuclear energy, the licences to operate the plants Biblis A and B, Neckarwestheim 1, Brunsbüttel, Isar 1, Unterweser, Philippsburg 1 and Krümmel expired. For the remaining nine nuclear power plants, the operating licences will expire between 2015 and the end of 2022.

The 12th amendment to the Atomic Energy Act – also of 8 December 2010 – introduced the obligation to conduct regular reviews and assessments of the safety of other nuclear installations, as e.g. local interim storage facilities, on the basis of Council Directive 2009/71/EURATOM of the European Union of 25 June 2009. Up to now, this obligation has only been applicable to nuclear power plants.

Germany will rapidly transpose COUNCIL DIRECTIVE 2011/70/EURATOM of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste [EUR 11] into national law.

The 60 m³ of liquid high active fission product solutions from the operation of the Karlsruhe reprocessing plant were vitrified in the period from September 2009 to June 2010 at the Karlsruhe Vitrification Plant (VEK). 140 canisters were produced from vitrification and subsequent flushing. At the end of November 2010, the vitrification plant was again shut down after successful and complete fulfilment of its task. The five casks of type CASTOR® HAW 20/28 CG filled with canisters were transferred to the interim storage facility "*Zwischenlager Nord*" (ZLN) of the EWN GmbH at Lubmin near Greifswald in February 2011.

Requirements for Germany resulting from the Third Review Meeting (Rapporteur's Report 2009)

The Rapporteur's Report to the Third Review Meeting 2009 summarises the planned measures for improving safety as well as the as yet outstanding requirements that were identified as a result of the German presentation before the Country Group. The progress made with these points during the review period is described in the following.

(1) Planned measures to improve safety

- *Adoption of the "Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste"*

The BMU has developed safety requirements for the disposal of heat-generating radioactive waste in Germany in accordance with the current international recommendations and standards on radiation protection and disposal of radioactive waste. The safety requirements put the state of the art in science and technology in concrete terms that is to be complied with regarding the construction, operation and closure of a repository for heat-generating waste and to be reviewed within the plan approval procedure by the respective licencing authority. The "Safety Criteria for the Final Disposal of Radioactive Wastes in a Mine" were adopted by the *Länder* Committee for Nuclear Energy (LAA) on 30 September 2010 and replace the "Safety Criteria for the Permanent Storage of Radioactive Wastes in a Mine" published in 1983.

- *Progress in the decision for developing a repository for heat-generating radioactive waste*

After the expiry of the moratorium on 30 September 2010, the underground exploration work at the Gorleben salt dome was resumed. In parallel, a preliminary safety analysis for the salt dome is in progress. The assessments on the preliminary safety analysis are to be performed in accordance with the "Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste" of the BMU of 30 September 2010. The results of the preliminary safety analysis are expected to be available in 2012 and will be subjected to an international peer review process in

2013 to review the safety assessment according to the state of the art in science and technology, and to document this review in a traceable and transparent manner. The decision on further actions will be taken on the basis of the resulting knowledge and assessments of the salt dome.

- *Closure of the Asse II mine*

Since 1 January 2009, the Federal Office for Radiation Protection (BfS) has been the operator of the repository mine Asse II. This was preceded by the decision of the Federal Government of 5 November 2008, to transfer the Asse II mine, which had so far been operated according to mining law, to the area of application of nuclear law and to operate it in future as a radioactive waste repository according to § 9a of the Atomic Energy Act (AtG) [1A-3]. The BfS was charged with taking over the facility on 1 January 2009 from Helmholtz Zentrum München – *Deutsches Forschungszentrum für Gesundheit und Umwelt* (HMGU), and operating and closing it according to the provisions applying to repositories. As an administrative assistant for the BfS, the federally owned Asse-GmbH was founded who is operating the mine on behalf of the BfS. Within the framework of a comparison of three closure options, the BfS examined how the Asse II mine can be safely closed. The options considered were the retrieval of the radioactive waste, the internal relocation of the radioactive, and the complete backfilling of the mine. As a result of the comparison of options, the BfS concluded that, taking the present state of knowledge into account, the preferred closure option would be the complete retrieval of the waste, since, at present, the long-term safety case can only be established for this variant. On 21 April 2011, the Lower Saxony Ministry for the Environment and Climate Protection granted the licence for drilling into two representative emplacement chambers upon application of the BfS for further fact finding.

- *Development and presentation of a national waste management programme*

Germany will rapidly transpose Council Directive 2011/70/EURATOM of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste into national law. A national programme in compliance with the Directive that includes comprehensive measures for the sustainable management of radioactive waste and irradiated fuel assemblies already existing and expected to arise in future will be presented within the timeframe specified by the Directive, presumably in 2015.

- *Update of the German rules and regulations on the decommissioning of nuclear installations and on the interim storage of spent fuel following the WENRA process*

The review of the relevant German rules and regulations for the interim storage of spent fuel and radioactive waste, concluded in 2009 within the framework of the Western European Nuclear Regulator's Association (WENRA), showed that there are differences compared to the safety reference levels of the WENRA in the regulatory equivalence of the subject areas management system, emergency planning and periodic safety review requiring adaptations of the German non-mandatory guidance instruments. The respective national action plan has been prepared. In a first step, the Nuclear Waste Management Commission (ESK) developed recommendations in 2010 for guides to the performance of periodic safety reviews for irradiated fuel assemblies and heat-generating radioactive waste. The revision of the safety guidelines for interim waste storage facilities and for dry interim storage of irradiated fuel assemblies in storage casks by the ESK takes place in 2011 and 2012.

- *Planned revision of clearance levels*

Due to the changes in waste law, the clearance levels for the clearance of waste for disposal (dumping and conventional waste incineration) were revised. It is planned to make these mandatory in the forthcoming amendment of the Radiation Protection Ordinance.

(2) Still existing requirements from earlier Rapporteur's Reports

- *Repository concept and siting for heat-generating waste*

The commissioning of a repository in deep geological formations for the disposal of heat-generating radioactive waste is planned for around the year 2035. Exploration of the Gorleben salt dome was continued again in October 2010. It is expected that the exploration activities will come to an end around the year 2020, with a final statement on the site's suitability.

- *Konrad: conversion of the mine into a repository*

The Konrad mine has been licenced as a repository for radioactive waste with negligible heat generation. The plan approval decision notification for the Konrad repository served on 22 May 2002 became legally valid on 26 March 2007 following the dismissal of claims and rejection of appeals launched against it.

The conversion of the Konrad mine into a repository for radioactive waste with negligible heat generation has begun in the meantime. Preparatory measures have been carried out at the building sites, such as the search for unexploded ordnance and the removal of industrially contaminated soil layers. The planned demolition of old structures with no further use has been completed.

The building site installations and the first structures (underground media ducts, foundations of new buildings) are already in place within the grounds of the Konrad repository. The necessary structural refurbishment of the Konrad 1 and 2 mines is largely complete; excavation of underground side chambers and the first emplacement chamber has begun. Underground, work to overhaul the large vehicles as well as the hauling and transport machinery is pushed on. Parts of the emplacement area are currently being prepared.

Comprehensive competitive tendering procedures were prepared and tenders invited. At the present stage, construction of the repository is not expected to be complete before 2019.

The work in connection with the construction of the Konrad repository also includes the adaptation to the "Konrad Waste Acceptance Requirements for Final Disposal". These include above all the consideration of additional waste-specific provisions from the plan approval notice and the expansion of the radionuclide spectrum.

- *Asse II Mine: stabilisation of the underground workings to ensure radiological long-term safety; performance of a safety analysis*

After having taken over the operatorship on 1 January 2009, the BfS first performed measures to improve stability and precautionary measures regarding the influent solutions. In addition, an emergency planning was set up for the case that the inflow of solutions reaches an uncontrollable level.

As part of the measures for hazard control, the complete filling of the remaining cavities in the former mine workings of the southern flank, where no radioactive waste has been emplaced, was initiated. At the time of taking over of the operatorship, nearly all mine workings of the southern flank were filled with salt rock (crushed salt). However, adequate stabilisation could not be achieved this way, since crushed salt has a high proportion of trapped air. Compression (compaction) of the injected material led to the formation of horizontal clefts at the roofs of the mine workings with an average height of 35 cm. Since 2009, these remaining cavities have been successively filled with a special type concrete consisting of rock salt, magnesium oxide and magnesium chloride solution (Sorel concrete). The aim of the measure is to slow down rock deformation thus improving the safety situation. Emplacement areas have not been affected by the backfilling measures taken so far. Since 8 July 2010, the Asse II mine has a licence for the handling of radioactive substances pursuant to § 7 StrlSchV [1A-8] for keeping the mine open.

- *Final closure of the Morsleben repository and sealing of the emplacement chambers*

Between 1971 and 1992, low- and medium-active waste from nuclear power plants as well as waste from research, medical and industrial application was emplaced in the Morsleben final repository for radioactive waste (ERAM). Also stored beside the radioactive waste emplaced there are sealed sources and low amounts of solid medium-active waste. Within the framework of the plan approval procedure for decommissioning, an application was made to move this waste to a repository.

Meanwhile, documents for the plan approval procedure for the backfilling and sealing of the Morsleben repository have been submitted to the competent licencing authority, the Ministry of Agriculture and the Environment of Saxony-Anhalt (MLU), and laid down for public inspection. Within the procedure for the planned closure of the ERAM, all citizens have the possibility to inspect the documents for the closure applied for from 22 October 2009 to 21 December 2009 and to raise objections at the MLU. After expiry of this period, the objections received will be examined and finally discussed in a public hearing conducted by the MLU. The MLU plans to conduct this hearing in the period from 13 October to 10 November 2011.

Parallel to the involvement of the general public in the plan approval procedure, the further planning of the decommissioning of the ERAM are also pushed on. These also comprise an "in-situ" experiment relating to the sealing structure in the salt rock as well as hazard control measures on the basis of mining-law-related licences. This is to ensure the stability of the mine by backfilling cavities in the central part of the mine. As part of this measure, 24 workings with a total cavity volume of about 914 500 m^3 had been backfilled by the end of 2010. The intention is to bring the plan approval procedure for the closure of the facility to a conclusion in 2014 and subsequently start with the sealing of the repository.

- *Rules for financing spent fuel and radioactive waste management to guarantee transparency*

The management of spent fuel and radioactive waste is based on the polluter-pays principle. The generators of residual radioactive materials have to ensure that these are re-used in a non-hazardous manner or properly disposed of as radioactive waste. This means that on principle the generators have to take care of the conditioning and interim storage of spent fuel and radioactive waste.

The polluter-pays principle also applies to the funding of the disposal of spent fuel and radioactive waste. Regarding the disposal of spent fuel and radioactive waste and for the actual decommissioning of nuclear installations, the respective private operators are obligated to build up sufficient financial reserves. The public operators set aside the corresponding funds for dismantling and decommissioning in their respective current budgets.

The necessary expenditures of those obliged to hand over the waste to plan and construct a repository are refinanced by the Federation via advance payments on contributions. The use of repositories and *Land* collecting agencies is refinanced via charges and fees that the delivering parties have to pay.

As the continued monitoring of a repository after its closure is a federal task, the funds necessary for this purpose are provided by the Federation.

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 on 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 licencing 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 annexes to the report contain a list of nuclear facilities currently in operation as defined by this Convention with their safety-relevant design characteristics, a list of installations in the process of decommissioning 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 fourth German national report does not merely include modifications of the previous reports but provides an integrated overall description. Any major amendments since the report for the third Review Meeting in May 2009 are summarised at the beginning of the respective sections in an info box (Developments since the third Review Meeting).

The information provided by the report applied as at the deadline of 31 March 2011 unless expressly specified otherwise.

The fourth 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 and radioactive waste in Germany. These are the nuclear regulatory authorities of the Federation and the *Länder*, supported by expert organisations, as well as the energy utilities as important waste generators, involved by a representative of their joint most important service provider, *Gesellschaft für Nuklear-Service* (GNS) *mbH*. The report was approved by the Federal Cabinet at its meeting on 31 August 2011.

According to the national regulations of the Federal Republic of Germany, which are in line with the international requirements, the residual materials generated 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 and third Review Meeting - presented in a separately annexed report describing the status of the ecological restoration as at the end of the year 2010.

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 conjunction with Ann. 11, Chapter XII, Section III nos. 2 and 3 of the Unification Treaty of 31 August 1990 (Federal Law Gazette II 1990, p. 885) [1A-4] individual regulations of the former GDR shall continue to apply in new *Länder* 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 generated 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 generated waste 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 or 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 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

Beginnings of the use of nuclear energy in Germany

In the Federal Republic of Germany, research and development in the field of 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 disposal 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 Nuclear 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 Karlsruhe Institute of Technology (KIT),

in Jülich (*Kernforschungsanlage Jülich*, KFA, now *Forschungszentrum Jülich*, FZJ),

in Geesthacht (*Gesellschaft für Kernenergieverwertung in Schiffbau und Schifffahrt*, GKSS, now Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research),

1959 in Berlin (*Hahn-Meitner-Institut für Kernforschung*, HMI, now *Helmholtz-Zentrum Berlin*),

in Hamburg (*Deutsches Elektronen-Synchrotron*, DESY)

1964 in Neuherberg near Munich (*Gesellschaft für Strahlenforschung*, GSF, now Helmholtz Zentrum München - German Research Centre for Environmental Health)

1969 in Darmstadt (*Gesellschaft für Schwerionenforschung*, GSI).

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

Construction of power reactors in the Federal Republic of Germany

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 (PWRs and BWRs) of the 1 300 MWe class were built, the last of which commenced operation in 1989. The capacity of almost all new reactors has meanwhile been increased to over 1 400 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 prototype and demonstration power plants. 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. As early as 1960, the experimental nuclear power plant Kahl started operation as the first nuclear power plant in the Federal Republic of Germany, followed in 1966 by the nuclear power plant Gundremmingen A (KRB-A) as the first commercial boiling water reactor, and in 1968 the nuclear power plants in Lingen (KWL) and Obrigheim (KWO). Development work on a fast breeder at the former Karlsruhe Nuclear Research Centre also began in the early Sixties. 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 spent fuel is stored in the Ahaus Transport Cask Storage. Although the SNR was completed, it was never loaded with spent fuel. The SNR fuel that had been produced already is being processed in France into mixed-oxide (MOX) fuel for light water reactors.

<u>Construction of power reactors in the former GDR</u>

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 these five 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.

<u>Political development since 2000</u>

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 structured phase-out of the utilisation of nuclear energy for the commercial generation of electricity of 22 April 2002 [1A-2], based on the agreement between the Federal Government and the utilities of 11 June 2001 [BUN 00], established new boundary conditions for the use of nuclear energy in Germany. The structured phase-out was formulated as one of the purposes of the Atomic Energy Act (AtG) [1A-3]. The starting point for a gradual phase-out of the operation of the nuclear power plants was an average operating lifetime of 32 years. Other parts of the Atomic Energy Act that are relevant for the Joint Convention are as follows:

- The reprocessing of spent fuel from power reactors is abandoned and replaced instead by the direct disposal of the spent fuel. Since 1 July 2005, delivery of spent fuel to other European countries for reprocessing has been ended, spent fuel is kept on the premises of the nuclear power plants in interim storage facilities until their delivery to a federal facility for the disposal of radioactive waste.
- 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 evidence 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.

The 11th amendment to the Atomic Energy Act of 8 December 2010 extended the operating life of the nuclear power plants by an average of twelve years. With the 13th amendment to the Atomic Energy Act of 6 August 2011 as a consequence of the events in Japan, which led to a reassessment of the risks associated with the use of nuclear energy, the licences to operate the plants Biblis A and B, Neckarwestheim 1, Brunsbüttel, Isar 1, Unterweser, Philippsburg 1 and Krümmel expired. For the remaining nine nuclear power plants, the operating licences will expire between 2015 and the end of 2022.

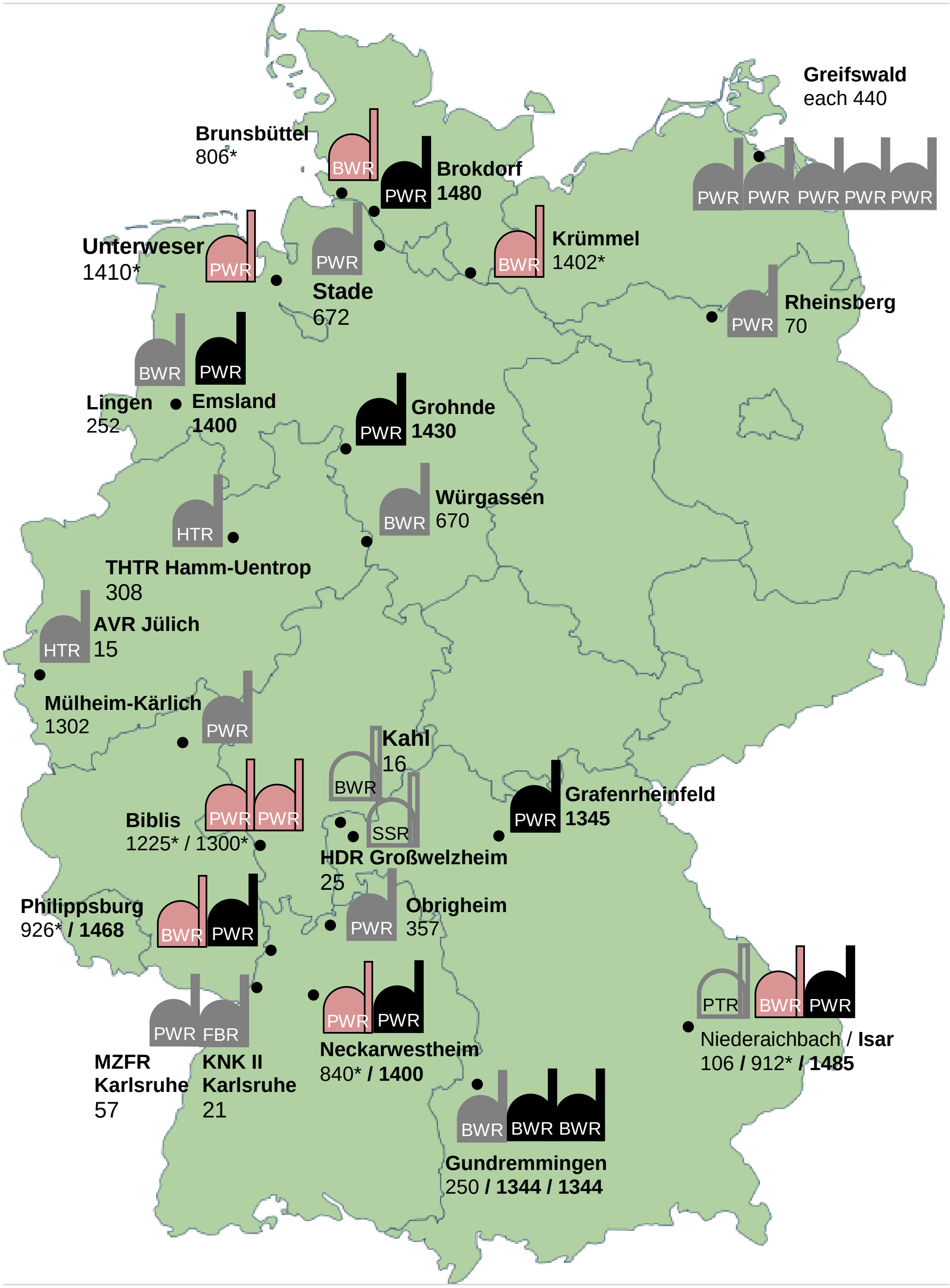
<u>Current situation</u>

Reactors with a lower capacity from the early years of nuclear power use have meanwhile been taken out of operation, and are in different stages of decommissioning. Three of them have been dismantled and the land recultivated. Four larger power reactors have likewise been deactivated. Dismantling at Würgassen is far advanced, whilst in the case of Mülheim-Kärlich it has been started in 2004. Dismantling of the Stade nuclear power plant is also far advanced, and several decommissioning licences have been granted, the last in February 2011. The Obrigheim nuclear power plant was closed down on 11 May 2005; the first decommissioning and dismantling licence was granted on 28 August 2008.

In total, 19 nuclear power plants in Germany are currently in the process of decommissioning or have been dismantled, or their decommissioning has been applied for (cf. Table L-14). In Germany, nuclear energy accounts for almost 23 % of the gross electricity production (as at 2010).

The geographical locations of the operating and decommissioned German nuclear power plants are shown in Figure A-1.

Figure A-1: Nuclear power plants in Germany



08/2011

Legend

PWR	Pressurised 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

*License terminated according to the 13th Act on the Revision of the Atomic Energy Act

completely dismantled

Numbers indicate gross capacity [MWe]

Considerations and strategies on the disposal of radioactive waste

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 (printed paper of the German *Bundestag* 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 had to be demonstrated six years in advance.

Nuclear fuel cycle

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 generated radioactive waste also began to emerge.

In the past, facilities for the fabrication of uranium, HTR and MOX fuel were operated at the Hanau site. However, these have since all been closed and dismantled; only facilities for groundwater remediation remain in operation at one site. 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.

In Karlsruhe, the Karlsruhe Reprocessing Plant (WAK) was built under the leadership of the local research centre, and put into operation in 1971. As a pilot plant, it had the task to gain experience for planning, construction and operation of a larger German reprocessing plant. In addition, methods for reprocessing and waste treatment were to be further developed. The technical scale was chosen such that direct application of operating experience to a large industrial plant was possible.

In the 1970s, the German utilities 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), consisting of a reprocessing plant, fuel fabrication plants for uranium and MOX fuel, 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. details in Chapter H.3.2). 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 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 licencing procedure was cancelled. From then onwards, the utilities exclusively turned their attention instead to reprocessing in foreign European countries. Until June 2005, spent fuel was transported to France and Great Britain for reprocessing. The plutonium separated during reprocessing is processed into MOX fuel and completely recycled in German light water reactors. So far (as at 31 December 2010), about 87 % of plutonium already separated or still to be separated have been recycled.

The reprocessing plant at Karlsruhe was decommissioned in 1990 and is currently in the process of being dismantled. The approximately 60 m³ of highly radioactive solutions of fission products from operation were vitrified at the Karlsruhe Vitrification Plant (VEK) in the period from September 2009 to June 2010. 123 canisters and thus about 49 Mg of waste glass were produced. During subsequent flushing as much activity as possible was removed from the casks, pipes and the melting furnace, thus producing another 17 canisters with a lower activity inventory and lower thermal output. At the end of November 2010, the vitrification plant was shut down after successful and complete fulfilment of its task. The five casks of type CASTOR® HAW 20/28 CG filled with canisters were transferred to the interim storage facility "*Zwischenlager Nord*" (ZLN) of the EWN GmbH at Lubmin near Greifswald.

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

Interim storage of spent fuel

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 (§ 9a AtG [1A-3]). The operators of the nuclear power plants have to demonstrate that provisions for the handling and disposal of the spent fuel 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 with the objective of disposal. In particular, they have to take care that on-site interim storage facilities for the storage of the fuel assemblies until their dispatch to a federal repository are built and operated.

On-site interim storage facilities have been constructed and commissioned at all sites of the nuclear power plants still in operation for spent fuel in transport and storage casks (cf. Table L-14). For the decommissioned Obrigheim NPP, commissioning of an on-site interim storage facility is planned. The licencing procedure is currently underway.

Conditioning of spent fuel

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

The sites of the facilities for the interim storage, conditioning and disposal of spent fuel and radioactive waste - as far as they have not been constructed at the locations of nuclear power plants in operation at that time - are shown in Figure D-1.

Disposal

Development work in the field of repositories began with the installation of the Asse II mine in a disused salt mine in 1965, where low- and medium-active waste was emplaced between 1967 and the end of 1978. According to § 57b of the Atomic Energy Act (AtG) [1A-3], the Asse II mine must be decommissioned without delay. Here, the provision applicable to federal installations referred to in § 9b AtG shall be applied mutatis mutandis. The Federal Office for Radiation Protection (BfS), as the responsible operator of the facility, applied for the initiation of a plan approval procedure under nuclear law at the competent Lower Saxony Ministry for the Environment and Climate Protection with letter of 11 February 2009.

Since 1988, there has been a continuous inflow of groundwater from the overburden into the mine. At the same time, the stability of the mine deteriorates successively due to the pressure of the overlying overburden and the decreasing load-carrying capacity of the mine workings. Within the framework of a comparison of three closure options, the BfS examined how the Asse II mine can be safely closed. The options considered were the retrieval of the radioactive waste, the internal relocation of the waste, and the complete backfilling of the mine.

On 15 January 2010, the Federal Office for Radiation Protection (BfS) as the operator announced that, taking the present state of knowledge into account, the complete retrieval of all waste would constitute the best closure option. However, the retrieval of the waste requires more detailed knowledge of the state of the waste and other conditions to be able to ensure the safety of the employees and the public (“finding of facts”). On 21 April 2011, the Lower Saxony Ministry for the Environment and Climate Protection granted the licence for drilling into two representative emplacement chambers upon application of the BfS as a first step of fact finding.

The Nuclear Waste Management Commission (ESK) points out that in the case of retrieval of the waste from the Asse II mine, it is currently not possible to make substantiated estimates of the radiation exposure of personnel and the public. In the case of complete retrieval of the waste, additional radiation exposure for the operating personnel and the public would have to be accepted over the next decades. The conservatively calculated potential future doses in the case that the waste remains in the Asse II mine must be weighed against this.

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 the German reunification, this repository was used for the emplacement of further low- and medium-active waste from the whole reunified Germany up until September 1998. Meanwhile, documents for the plan approval procedure for the backfilling and sealing of the Morsleben repository have been submitted to the competent licencing authority, the Ministry of Agriculture and the Environment of Saxony-Anhalt (MLU), and laid down for public inspection from 22 October to 21 December 2009. During the period of public inspection, the MLU received more than 12 000 objections. The MLU plans to conduct the hearing from 13 October to 10 November 2011.

For the Konrad mine, a former iron ore mine, plan approval was applied for in 1982 regarding the construction 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. With letter of 30 May 2007, the Federal Office for Radiation Protection (BfS) was commissioned by the BMU with the conversion of the Konrad mine into a repository for radioactive waste with negligible heat generation. The related work is in progress. The demolition of the aboveground infrastructure no longer needed is well advanced now; the reconstruction of the shafts Konrad 1 and 2 has started. Underground, the repair of large-size vehicles as well as hoisting and transport equipment is being pursued. Parts of the emplacement area are being prepared. Emplacement operation is expected to start in 2019.

At the Gorleben site, following aboveground 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 heat-generating radioactive waste. On the basis of the agreement between the Federal Government and the utilities of 11 June 2001, the work for exploration of the Gorleben salt dome has been suspended since 1 October 2000 for ten years to clarify conceptual and safety-related questions. 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 disposal in salt rock as compared to other host rock formations 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. The geological findings obtained until the start of the moratorium do not contradict a potential suitability of the Gorleben salt dome.

In October 2010, the exploration of the Gorleben salt dome was resumed. In parallel, a preliminary safety analysis on the issue of long-term safety is to be prepared by the end of 2012 which is then to be subjected to an international peer review.

Tailings from uranium ore mining

In 1946, a Soviet owned stock company began mining uranium ore on the territory of 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.

A.3. Political development

The 11th amendment to the Atomic Energy Act of 8 December 2010 extended the operating lives of the German nuclear power plants by an average of twelve years. For nuclear power plants with start of power operation until including 1980, the assigned volumes of electricity were increased such that there was an extension by eight years. For younger nuclear power plants, the increase was equivalent to a lifetime extension by 14 years.

With the 13th amendment to the Atomic Energy Act of 6 August 2011 as a consequence of the events in Japan, which led to a reassessment of the risks associated with the use of nuclear energy, the licences to operate the plants Biblis A and B, Neckarwestheim 1, Brunsbüttel, Isar 1, Unterweser, Philippsburg 1 and Krümmel expired. For the remaining nine nuclear power plants, the operating licences will expire between 2015 and the end of 2022 (see Table A-1).

Table A-1: Electricity volumes and dates of shutdown according to the 13th amendment to the Atomic Energy Act

Plant	Electricity volumes as from 1 January 2000 [TWh net]	Start of commercial power operation	Expiry of licence for power operation
Obrigheim	8.70	01.04.1969	-
Stade	23.18	19.05.1972	-
Biblis A	62.00	26.02.1975	06.08.2011
Neckarwestheim 1	57.35	01.12.1976	06.08.2011
Biblis B	81.46	31.01.1977	06.08.2011
Brunsbüttel	47.67	09.02.1977	06.08.2011
Isar 1	78.35	21.03.1979	06.08.2011
Unterweser	117.98	06.09.1979	06.08.2011
Philippsburg 1	87.14	26.03.1980	06.08.2011
Grafenrheinfeld	150.03	17.06.1982	31.12.2015
Krümmel	158.22	28.03.1984	06.08.2011
Gundremmingen B	160.92	19.07.1984	31.12.2017
Philippsburg 2	198.61	18.04.1985	31.12.2019
Grohnde	200.90	01.02.1985	31.12.2021
Gundremmingen C	168.35	18.01.1985	31.12.2021
Brokdorf	217.88	22.12.1986	31.12.2021

Plant	Electricity volumes as from 1 January 2000 [TWh net]	Start of commercial power operation	Expiry of licence for power operation
Isar 2	231.21	09.04.1988	31.12.2022
Emsland	230.07	20.06.1988	31.12.2022
Neckarwestheim 2	236.04	15.04.1989	31.12.2022
Sum	**2516.06**		
Mülheim-Kärlich	107.25		
Total	**2623.31**		

The electricity volume of 107.25 TWh for the Mülheim-Kärlich nuclear power plant can be transferred to the nuclear power plants Emsland, Neckarwestheim 2, Isar 2, Brokdorf, Gundremmingen B and C.

The coalition partners in the Federal Government specified in their Coalition Agreement of 26 October 2009 that the responsible use of nuclear energy also necessitates safe disposal of radioactive waste and it had been agreed to lift the moratorium on exploration at the Gorleben salt dome as a repository for heat-generating radioactive waste to continue open-ended exploration work.

After expiry of the moratorium for the Gorleben salt dome in October 2010, the exploration of the salt dome as a repository for heat-generating radioactive waste, i.e., in particular, spent fuel and high-level fission product solutions, was resumed. On the basis of the new safety requirements on the disposal of heat-generating radioactive waste, a preliminary safety analysis is to be prepared for a potential Gorleben repository by the end of 2012. Focus of this preliminary safety analysis, which was performed by the *Gesellschaft für Anlagen- und Reaktorsicherheit* (GRS) on behalf of the Federal Ministry for the Environment, Nature Conservation and Reactor Safety (BMU) comprises all the existing knowledge about the salt dome and the previous exploration results, is the issue of long-term safety. The primary objective of the project is a traceably documented prognosis on the basis of previous findings whether the Gorleben site can fulfil the new "Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste" of the BMU of 30 September 2010 [BMU 10]. It is to be explained in a comprehensible manner, if at all - and if so, under what conditions - a safe repository at this site can be realised. In addition, an optimised repository concept, taking the operational safety into account, is to be developed, and the future need of investigations and exploration is to be identified.

The preliminary safety analysis is subsequently to be peer reviewed by international experts to ensure that the internationally accepted standards and the state of the art in science and technology are complied with. The preliminary safety analysis then serves as a planning base for further exploration. Only after completion of the open-ended exploration and a possible determination of the suitability of the salt dome, a second and final safety analysis is provided as part of the plan approval procedure to be performed by the Lower Saxony nuclear licencing authority.

Within the framework of the twelfth amendment to the Atomic Energy Act of 8 December 2010, a possibility to access private rights of third parties, deleted in the amended Atomic Energy Act of 2002, has been re-introduced.

In a Statement for the Council Minutes as part of the debate of the Federal Council (*Bundesrat*) with the 13thAct to amend the Atomic Energy Act, on 8 July 2011, the Federal Government confirmed that the generations that use nuclear energy must also make provision for the storage of radioactive waste. This will involve the continuation of open-ended exploration of the salt dome in Gorleben, as well as a procedure to determine general criteria for the geological suitability and to identify possible waste management options. The Federal Government will put forward a proposal for legislation on these matters by the end of 2011.

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 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 licencing and supervisory authorities, and the supervision of administrative actions by independent courts. The legislation, administrative authorities and jurisdiction generated 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, operation and decommissioning 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 [IAEO 06] are taken into account. One principal objective of the German Federal Governments 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-2 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 in Germany.

Table A-2: Treatment of radioactive waste and spent fuel in Germany

Waste management task	Long-term strategy	Financing	Current practice / installations	Planned installations
Spent fuel	Interim storage in casks; subsequently conditioning and direct disposal in deep geological formations; in the case of spent fuel for research reactors transport to the country of origin or disposal	Setting aside provisions for nuclear asset retirement by installations owned by the utilities for the future costs of waste conditioning and for construction, operation and closure of a repository; refunding as adequate for the generator of the costs incurred by the Federation; financing from public funds in the case of state-owned installations (polluter-pays principle)	4 central dry storage facilities, 12 dry storage facilities at the nuclear power plant sites, 1 wet storage facility (Obrigheim)	1 wet storage facility (Obrigheim), 1 repository project in the process of exploration
Radioactive waste from the nuclear fuel cycle and the operation of the nuclear power plants	Interim storage at the site of origin or centrally with the aim of disposal in deep geological formations	See “Spent fuel” (polluter-pays principle)	Conditioning and interim storage (at the site of origin or centrally)	Waste with negligible heat generation: 1 repository licenced; in the process of refitting; commissioning approx. 2019 Heat-generating waste: 1 repository project in the process of exploration
Other radioactive waste	Interim storage at central sites with the aim of disposal in deep geological formations	Waste generators pay fees to the *Land* collecting facilities (polluter-pays principle); *Land* collecting facilities pay repository cost portion to the Federation	Conditioning and interim storage (*Land* collecting facilities)	1 repository licenced; in the process of refitting; commissioning approx. 2019
Decommissioning of nuclear facilities	Green field (with unrestricted release of the largest part of the radioactive residuals) or further use as industrial site	Setting aside provisions for nuclear asset retirement by installations owned by the utilities and in the case of nuclear fuel cycle installations; 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 generators pay fees to the *Land* collecting facilities (polluter-pays principle); *Land* collecting facilities pay repository cost portion to the Federation	Conditioning and interim storage (*Land* collecting facilities)	1 repository licenced; in the process of refitting; commissioning approx. 2019

B. Policies and practices

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

> *Article 32 (1): 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 in Germany. In Germany, the reprocessing of spent fuel would be classified under "management" within the meaning of this Convention. However, as Germany has delivered spent fuel to France and the United Kingdom for reprocessing, it will not be reported here on the reprocessing of German spent fuel. There is no spent fuel 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 naturally occurring radioactive material (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 re-using the fissile material in the spent fuel. 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 of direct disposal.

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

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

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

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

The aim is to commission a repository in deep geological formations for the disposal of heat-generating radioactive waste around the year 2035.

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 by means of its re-use as MOX fuel in reactors, and the safe storage of all uranium.

All other types of spent fuel remaining in Germany, and those which will continue to be generated will be stored in an interim storage facility until their final transportation to 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 licenced for transport and storage. Spent fuel from decommissioned power reactors of Soviet design at Greifswald and Rheinsberg are likewise stored dry in casks at the interim storage facility "*Zwischenlager Nord*" (ZLN) at Greifswald. An application to construct an interim storage facility for the dry storage of spent fuel 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 evidence for the backfilling of cavities and the sealing of drifts and shafts. Measures for retrieval after sealing of a repository are not part of this concept. The "Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste" of 30 September 2010 [BMU 10] requires for the first time the possibility of retrieval of the radioactive waste during the operational phase of the repository.

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 generated 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 disposal if it cannot be released after the radioactivity has decayed.

The aim is to commission a repository in deep geological formations for the disposal of heat-generating radioactive waste around the year 2035.

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 be 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 at the major research centres; there are also a number of other stationary conditioning installations which are operated on site by the respective waste generators.

In addition to German facilities, facilities in other European foreign countries are also utilised for waste management. Radioactive waste generated from the operation of nuclear installations is delivered to Sweden for conditioning and subsequently returned to Germany. Waste from the reprocessing of spent fuel from German power reactors is conditioned in France and the United Kingdom (e.g. vitrification of the high-level fission product solutions) and is 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 generated from the use and handling of radioisotopes in research, industry and medicine (cf. the explanatory comments on Article 32 (1) iii), *Land* collecting facilities operated by the *Länder* are available for interim storage.

On the basis of the current licencing situation, heat-generating radioactive waste may be kept in interim storage in decentral 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 preliminary stored in research institutions and, to a lesser extent, also in *Land* collecting facilities.

Compliance with the waste acceptance requirements is verified within the scope of the product control procedure. In the case of legacy waste, qualification is possible by checking samples.

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. On 9 May 1997, the initiation of a plan approval procedure pursuant to

§ 9b Atomic Energy Act (AtG) [1A-3] was applied for at the competent plan approval authority of the *Land* of Saxony-Anhalt for the closure of the ERAM. Within the procedure for the planned closure of the repository for low- and medium-level waste at Morsleben, all citizens had the possibility to inspect the documents for the closure applied for from 22 October 2009 to 21 December 2009 and to raise objections at the Ministry of Agriculture and the Environment of Saxony-Anhalt (MLU) being responsible for the licencing procedure. After expiry of this period, the objections received will be examined and finally discussed in a public hearing conducted by the MLU. The MLU plans to conduct this hearing in the period from 13 October to 10 November 2011.

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. The conversion of the Konrad mine into a repository for radioactive waste with negligible heat generation has started. The project plans for the emplacement operations are currently being updated. The Konrad repository may exclusively accept German radioactive waste with negligible heat generation and a waste package volume of a maximum of 303 000 m^3. This radioactive waste has to be shown to fulfil the waste acceptance requirements for disposal, including the auxiliary conditions of the plan approval notice.

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 (AtG) [1A-3], 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).

The compliance with the release limits ensures that during the re-use or the disposal of radioactive waste any noticeable exposure of the general public is precluded. There is a range of possibilities for the re-use of radioactive waste. Released tools and installations from decommissioned plants may be used e.g. in other nuclear power plants or in conventional plants. Metals may be recycled by melting them down. Rubble may be used as raw material in road-building, for backfilling of landfill or for the production of concrete. For electronic scrap conventional recycling is applied, too.

In Germany, the intention is that all types of radioactive waste should be stored in deep geological formations. This applies to waste from the reprocessing of spent fuel from German nuclear power plants at facilities in other European countries, to waste from the operation and decommissioning and/or dismantling of commercially operated nuclear facilities as well as to 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 prerequisite 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 to 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 II mine and the Morsleben repository. Here, the waste categories LAW and MAW were used during the operational phase.

Heat-generating radioactive wastes are 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, and thermal design of the repository mine). Those wastes include in particular the fission product concentrate, shells, structural components and feed sludge from the reprocessing of spent fuel, and the spent fuel itself if there are no plans to reprocess it but instead to dispose of it as radioactive waste. All the waste from the reprocessing of German LWR spent fuel at La Hague and Sellafield is vitrified and is filled into canisters (gross volume 180 litres, filling quantity 150 litres).

Wastes with clearly lower activity concentrations from the operation and decommissioning/dismantling of nuclear installations and facilities as well as from the application of radioisotopes are 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, 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 to the change of temperature caused by ventilation. The temperature difference of 3 Kelvin corresponds to an average heat output of about 200 W per m^3 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. Cast-iron containers, concrete containers 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) [1A-8]). 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: October 2010, Konrad Mine) [BfS 10] is one such example. These requirements specify the final description or categorisation of waste from a repository-specific point of view.

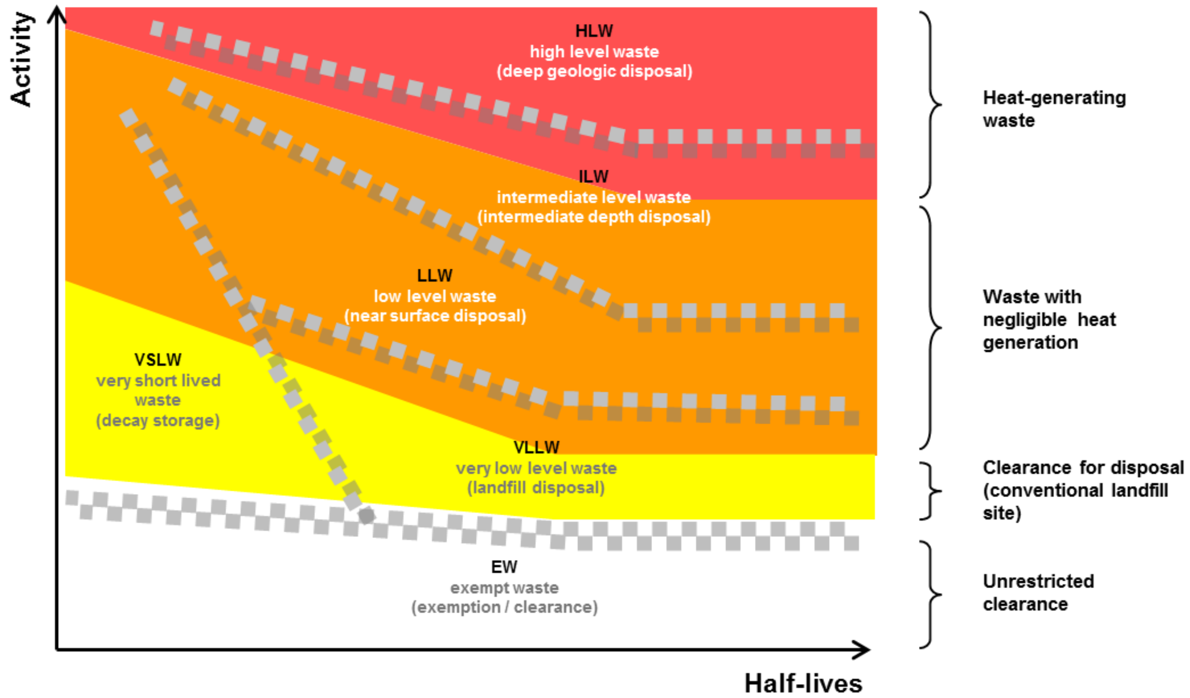
The categorisation of the waste into heat-generating waste and waste with negligible heat generation has not only proven expedient at national level, but is also applied internationally - e.g. by the Commission of the European Union - in connection with the categorisation of radioactive waste. It is compatible with the IAEA proposal for categorisation [IAEO 09] 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 General Safety Guide No. GSG-1 “Classification of Radioactive Waste” [IAEO 09], the IAEA has recommended 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 disposal. 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.

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



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

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

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

C.2. Distinction between NORM and radioactive waste

The Basic Safety Standards of the IAEA [IAEO 96] contain common regulations on radioactive material from nuclear installations or from other licenced 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 licenced 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 (StrlSchV) 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

The term "practices" refers to the use of a material's radioactive properties. This may include, for example, the operation of nuclear installations, spent fuel 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 national report.

C.2.2. Work activities

The term "work activities" refers to actions involving materials which, although containing naturally occurring radionuclides, are not used for their radioactive properties. Of importance for the protection of the population is the recycling or removal of residues from certain industrial processes with elevated contents of naturally occurring radionuclides of the U-238, U-235 and Th-232 decay chains. Examples include excavated materials from mining activities, fly ashes from combustion processes, residues from flue-gas purification of coal-fired power plants and slag from ore smelting. So, among other things, their use as construction aggregate is to be limited. As until now no radioactive wastes in terms 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 [1A-8]). The regulations referring to residues and other materials 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 StrlSchV, 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 conjunction with Part A StrlSchV. Appendix XII, Part A includes the list of residues which have to be taken into account with specification of the application areas and branches in which such residues may arise and 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 as

   b) 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 StrlSchV [1A-8] 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 StrlSchV after completion of the work activities or in accordance with § 118, para. 5 StrlSchV or from properties.

The possibility of 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 StrlSchV [1A-8], surveillance is not required according to § 97, para. 2 StrlSchV. If the surveillance limits are exceeded and it can be demonstrated in a case-specific evaluation according to § 98, para. 1 StrlSchV 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 StrlSchV can be applied in this procedure.

The surveillance limits provided in Appendix XII, Part B StrlSchV 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 will not be 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 StrlSchV [1A-8]. It prescribes that the person who is responsible according to § 97, para. 1 StrlSchV 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 generated 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 StrlSchV, § 102 StrlSchV 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 StrlSchV 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 higher level NORM, including geothermal plants, 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 that compliance with the dose reference level on the basis of case specific evaluations could be demonstrated. Incrustations from the oil and gas industry, for which compliance with the dose reference level cannot be demonstrated, could have been handed over to *Land* collecting facilities so far due to their low total amount. Thus, at present, there is no need for a separate facility for the surveillance of any remaining NORM residues.

C.3. Waste from the military sector

There is no spent fuel 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 an 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.

Developments since the third Convention:

An application for a licence for storage of nuclear spent fuel in the Ahaus facility in form of irradiated nuclear fuels from the former experimental nuclear power plant at Jülich (AVR) in 152 transport and storage casks has been made by the *Brennelement-Zwischenlager Ahaus GmbH* (BZA) and the *Gesellschaft für Nuklear-Service mbH* (GNS).

The licence for the interim storage of low and medium-active waste in the Ahaus facility was granted. The licence for the storage period is limited to ten years.

The four transport and storage casks with irradiated and not irradiated nuclear fuel from the decommissioned nuclear ship Otto Hahn and from the experimental reactor KNK II in Karlsruhe are returned from France to the interim storage facility "*Zwischenlager Nord*" (ZLN).

By the end of 2010 the existing HAWC solution was vitrified in the Karlsruhe Vitrification Plant (VEK) and filled into 140 stainless-steel canisters. The stainless-steel canisters were emplaced in five transport and storage casks and transferred to the ZLN.

At the Konrad interim storage facility area first construction measures were conducted. The necessary ecological restoration of the shafts has largely been completed and the drifts of underground mine works and of the first disposal room have been started.

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

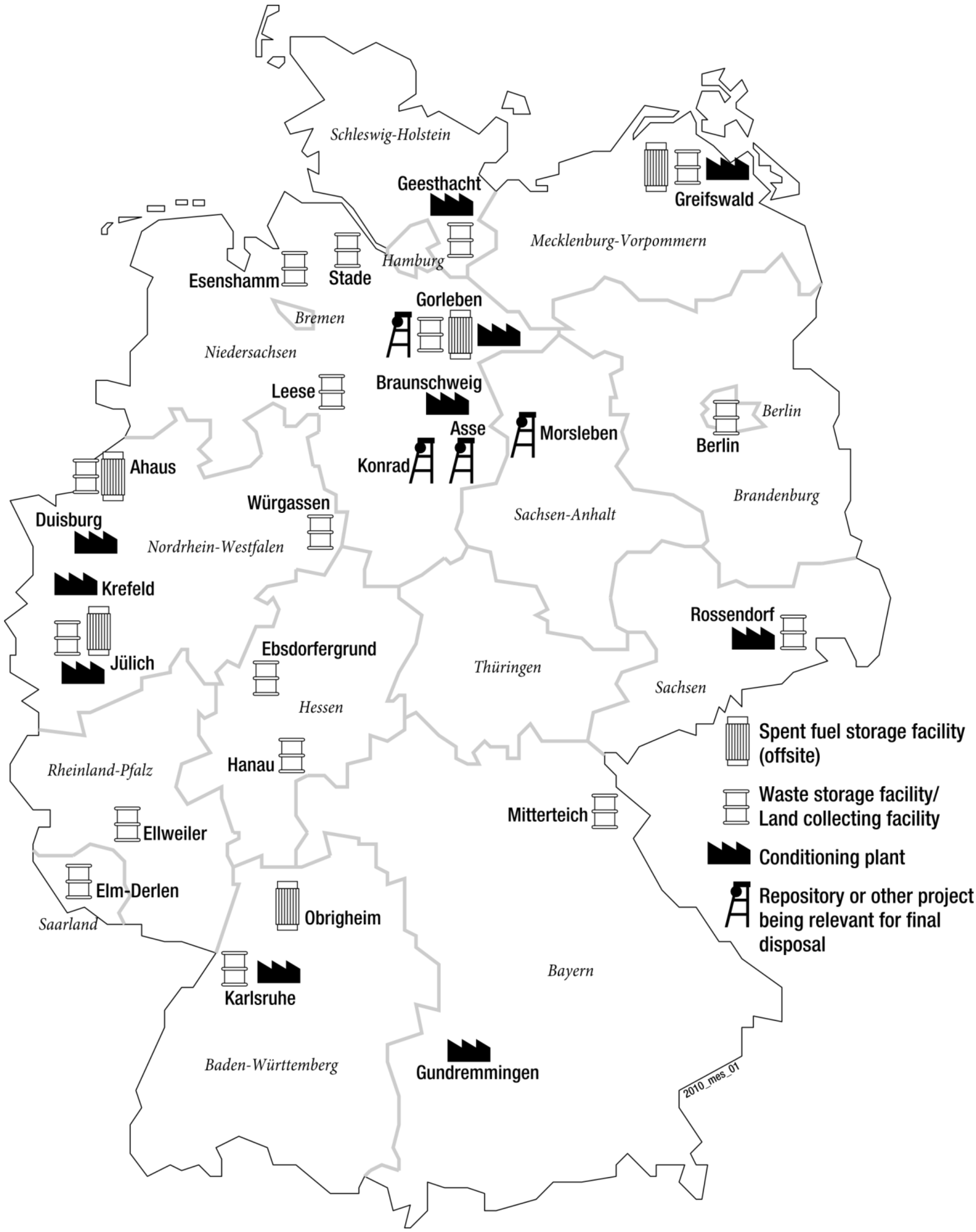
c) has resulted from past practices.

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.

The sites of the facilities for the interim storage, as well as conditioning and disposal of spent fuel facilities and radioactive waste – as far as they have not been constructed at the locations of nuclear power plants that were in operation at the time of the construction of the storage facilities, are shown in Figure D-1.

Figure D-1: Sites of storage facilities, conditioning plants, repositories and repository projects



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 "*Zwischenlager Nord*" (ZLN) at Greifswald 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 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 licencing 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.

On-site 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 Governments concept envisages that in future spent fuel is without exception to be placed in interim storage at the reactor sites where it is generated. It should remain there until duly conditioned and disposed of in a repository. Interim storage at the site means that spent fuel transports will be avoided until the disposal of the fuel with prior conditioning.

Decentralised interim storage facilities for spent fuel have been licenced under atomic law and constructed and commissioned at twelve sites with nuclear power plants. They are designed as dry storage facilities in which transport and storage casks loaded with spent fuel are emplaced.

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 licencing procedure that the casks are suitable for at least 40 years of storage; the licences limit the storage period correspondingly starting with the emplacement of the first cask. An extension of the storage period requires an authorisation.

At the Obrigheim nuclear power plant, an increase of the wet storage capacity in a pool outside the reactor building was licenced in 1998. The spent fuel remaining in the plant since its closure in May 2005 is 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 in a total of 15 storage casks. This application was modified with a letter of 31 October 2007. The concept envisages that, similar to the on-site interim storage facilities that have already been licenced 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 storage facilities used in the years 2001 to 2007 as an interim solution have all been emptied. The casks with the spent fuel have been transferred to the corresponding on-site interim storage facilities. The nuclear licences were returned or have expired.

Interim storage facilities at Gorleben and Ahaus

Central storage facilities containing spent fuel from various German nuclear power plants have been licenced at Gorleben (Figure D-2 and Figure D-3) and at Ahaus. The facilities are designed as dry storage facilities. Here, too, the types of casks for spent fuel are in part identical with those already mentioned above in conjunction with on-site storage facilities. The Ahaus facility is additionally licenced for storage of transport and storage casks of the types CASTOR® THTR/AVR und MTR 2 (Figure D-4 and Figure D-5).

It is intended to use the interim storage facility for the storage of further spent fuel from the research reactors (BER-II of the Helmholtz-Zentrum Berlin, of the TRIGA-reactor of the Technical University Mainz, and the *Forschungs-Neutronenquelle Heinz Maier-Leibnitz* (FRM II) of the Technische Universität München) in casks of the type CASTOR® MTR 2. No decision about this possibility has yet been made. Currently, it is not possible to make a prognosis about the planned storage in the TBL-A, as this depends on the potential use of other disposal paths by the operators of the research reactors (e.g. return to the USA).

With letter of 24 September 2009 the BZA and GNS have applied to the BfS, according to § 6 (AtG), for the storage of nuclear fuels in the form of spent fuel and other radioactive materials in the form of operating elements (absorber and graphite assemblies with no fissile material content) from the former AVR experimental reactor of AVR GmbH Jülich in a total of 152 transport and storage casks of the type CASTOR® THTR/AVR in the eastern part of the both storage areas (storage area II). Furthermore they applied for the storage of high-pressure-compacted radioactive waste in TGC36 transport and storage casks (the so called CSD-C resulting from reprocessing at La Hague).

On 9 November 2009 the competent district government of Münster granted a licence according to § 7 of the Radiation Protection Ordinance (StrlSchV) [1A-8] for the interim storage of operational and decommissioning waste in the western part of the two storage areas (storage area I). The storage period is limited to 10 years. On 21 July 2010 the first waste packages were emplaced.

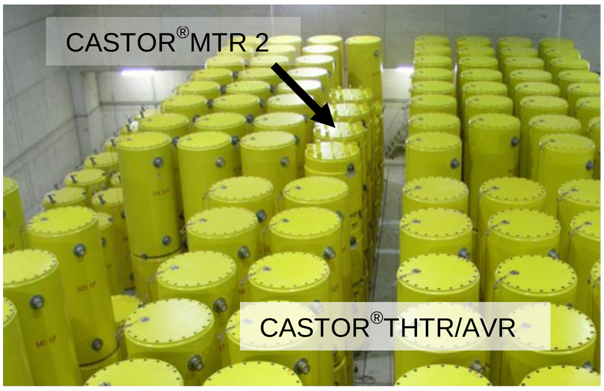
The interim storage facility at Gorleben is additionally licenced for the storage of HAW glass canisters. In January 2010 a licence for storage of CASTOR® HAW 28M type casks was granted. The storage of other conditioned radioactive materials in waste packages in separate areas of the interim storage facility is in preparation.

Figure D-2: Pilot conditioning plant (PKA), interim spent fuel storage facility (TBL-G) and interim waste storage facility (ALG) at Gorleben (Copyright: GNS)

Figure D-3: Transport and storage casks in the Transport Cask Storage Facility Gorleben (Copyright: GNS)

Figure D-4: Central interim storage facility for spent fuel at Ahaus (Copyright: GNS)

Figure D-5: Transport Cask Storage Facility Ahaus (Copyright: GNS)
left: CASTOR® V and CASTOR® THTR/AVR
right: CASTOR® MTR 2 between CASTOR® THTR/AVR



Interim Storage Facilities at Greifswald and Jülich

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

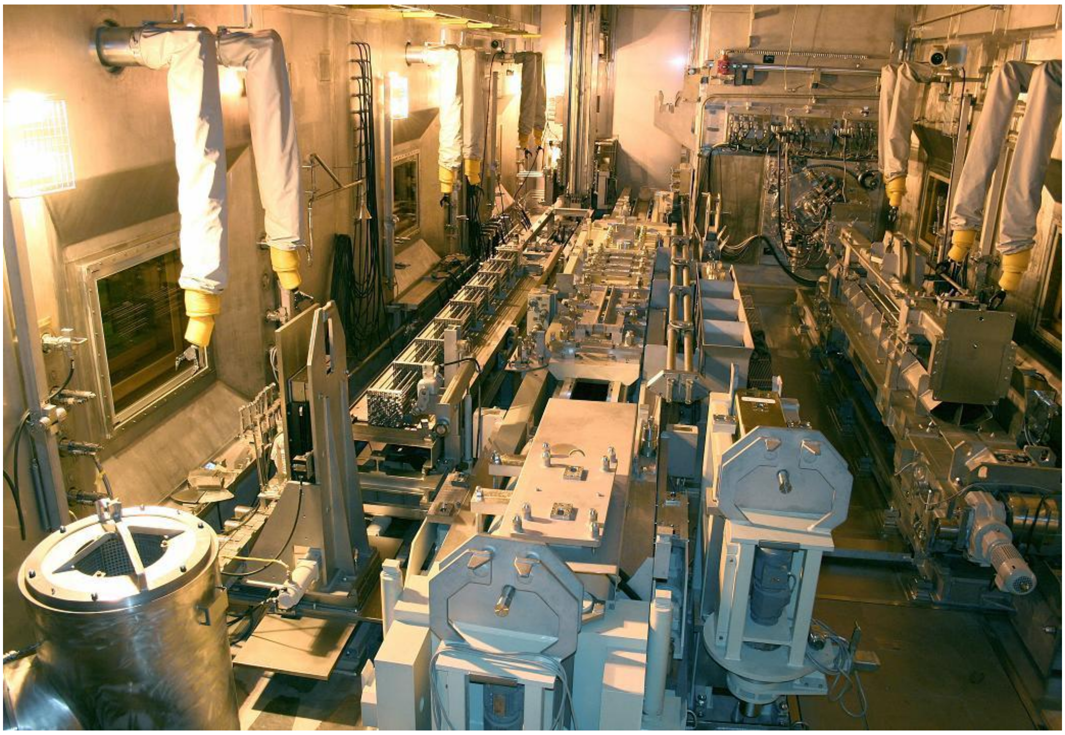
In the dry interim storage facility "*Zwischenlager Nord*" (ZLN) at Greifswald spent and fresh fuel assemblies from the Compact Sodium-cooled Nuclear Reactor Plant (KNK II) and from the Nuclear Ship Otto Hahn, as well as high-active glass canisters are currently stored apart from spent fuel from the Soviet-type reactors at Rheinsberg and Greifswald. The neighbouring former wet-storage facility (ZAB) has been completely emptied of fuel assemblies and the buildings have been dismantled. The final fuel assemblies were transferred to the ZLN in 2006. The KNK fuel assemblies were emplaced in 2010 and the glass canisters in 2011.

The interim storage facility at Jülich, licenced until 30 June2013, contains the spent fuel spheres from the operation of the experimental nuclear power plant at Jülich (AVR).The Interim storage facility is to be closed and the 152 stored transport and storage casks of the type CASTOR® THTR/AVR are to be transferred to the interim storage facility at Ahaus.

Pilot conditioning plant

The reference concept for direct disposal of spent fuel envisages the removing of the fuel rods from the fuel assemblies in an aboveground plant, the packaging of the fuel rods in self-shielding and sealed thick-walled casks and emplacing them in deep geological formations for disposal. The POLLUX reference concept (see below) is named after the type of cask used. In order to demonstrate the conditioning technique, a pilot conditioning plant (PKA) was finished at Gorleben in the year 2000 (cf. Figure D-6). The plant is licenced for a throughput of 35 Mg HM/a. Pursuant to the agreement between the Federal Government and the utilities of 11 June 2001, the licencing procedure is complete, but use of the facility is licenced only for the repair of defective casks for spent fuel from light-water reactors and for vitrified HAW from reprocessing 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 licence is therefore valid. As a prerequisite for the start of pilot operation, the licence requires the naming of a repository site and the qualification of the conditioning procedure.

Figure D-6: Segmenting cell in the PKA (Copyright: GNS)



The reference concept for the direct disposal of spent fuel has reached technical maturity. The concept envisages a drift emplacement of the casks. There is a prototype of a self-shielding and sealed thick-walled POLLUX cask. The proof of the technical reliability for the under-ground handling technique was furnished in the 1990s in a comprehensive over-ground experimental programme on full-scale shaft and drift transport and emplacement technique. About 2 000 emplacement cycles were performed; this corresponds to the total expected quantity of LWR fuel to be disposed of.

In a similar experimental programme on full scale, the basic feasibility and the reliability for canister storage in bore holes was demonstrated in 2009 for the alternative concept of the non-shielding fuel rod canister (BSK). This proof was also provided for the disposal of waste packages in bore holes from reprocessing. The shaft hoisting technology for the concept of fuel rod canister is the same as for the POLLUX concept. Essential basic development in regard of the radiological or material design of the BSK-3 (fuel rod canister to accommodate three PWR fuel assemblies) and the design of bore holes are currently outstanding.

The BSK-3-concept is based on the unshielded fuel rod canister storage in boreholes. A transfer cask for handling and for transfer of the BSK-3-canisters from the aboveground conditioning plant to the repository fulfils the function of shielding. Figure D-7 shows the test stand of the emplacement device, the transfer cask placed on the transport cart and the locomotive. The emplacement device receives the transfer cask, rotates it around the vertical axis and deposits it above the bore-hole. The BSK-3-canister, guided by cable, is lowered from the transfer cask and targetedly set down into the bore hole. The transfer cask is then available for the next BSK-3canister. The canister storage in bore holes offers considerable advantages over drift emplacement, e.g. the quicker enclosure of the waste package in salt with an improved heat transfer and the smaller free volume for potential inflow of liquid.

Both concepts – the POLLUX reference concept and the BSK-3-concept (to accommodate three PWR fuel assemblies) require the conditioning of the fuel assemblies which comprises the removal of the fuel rods from the fuel assemblies and the compacting of the structural parts of the fuel assemblies. Both concepts have now to be checked regarding their compatibility with the "Safety Requirements Governing the Final Disposal of Heat-Generating Waste" issued on 30 September 2010.

Figure D-7: Test stand for further development of the canister storage in boreholes

Furthermore, concepts for the disposal of undissected spent fuel assemblies are examined to simplify the above-ground handling effort with its special requirements on radiation protection.

Table D-1: a) Storage facilities for spent fuel (as at 31 December 2010) and b) Conditioning plant

Site	Storage capacity		Status		Emplaced
	(Number of storage positions)	[Mg HM]	Applied for	Licenced	[Mg HM]
Fuel pools in reactor buildings					
Nuclear power plants total	19 523 positions[1)]	Approx. 6 040[1)]		X	3 348
Onsite interim storage buildings					
Biblis	135 cask positions	1 400		X	468
Brokdorf	100 cask positions	1 000		X	134
Brunsbüttel	80 cask positions	450		X	51
Grafenrheinfeld	88 cask positions	800		X	133
Grohnde	100 cask positions	1 000		X	135
Gundremmingen	192 cask positions	1 850		X	280
Isar	152 cask positions	1 500		X	214
Krümmel	80 cask positions	775		X	175
Lingen/Emsland	130 cask positions[2)]	1 250		X	327
Neckarwestheim	151 cask positions	1 600		X	333
Obrigheim	980 positions[3)]	286		X	100
	15 cask positions		X		
Philippsburg	152 cask positions	1 600		X	357
Unterweser	80 cask positions	800		X	72
Centralised interim storage facilities					
Gorleben	420 cask positions[4)]	3 800		X	37[6)]
Ahaus	420 cask positions[5)]	3 960		X	55[7)]
Local storage facilities outside the reactor sites					
Greifswald	80 cask positions	585		X	583
Jülich	158 casks	0.225 nuclear fuel[8)]		X	0.075

1) Part of the storage capacity has to be kept free for unloaded cores.
2) Licenced for 125 cask positions for loaded casks and 5 casks 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) Including cask positions in the storage area I, on 26 May 2010 a licence for interim storage of operational and decommissioning waste, according § 7 StrlSchV [1A-8], to last for about 10 years was granted.
6) In addition 2 Mg HM in the HAW canisters.
7) Total amount from power reactors; an additional approx.6 Mg HM from the THTR and 2 Mg HM from the RFR Rossendorf.
8) Excluding Thorium.

b) Conditioning plant

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

D.2. Inventory of spent fuel

An overview of the spent fuel produced in German nuclear power plants up to the end of 2010 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.

Nine power reactors are currently operational in Germany, all of which are light water reactors whose spent fuel consists of low-enriched uranium dioxide or mixed uranium-plutonium oxide (MOX). With the 13th amendment to the Atomic Energy Act of 6 August 2011 the licences to operate the eight plants Biblis A and B, Neckarwestheim 1, Brunsbüttel, Isar 1, Unterweser, Philippsburg 1 and Krümmel expired. 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 (completely dismantled in 2010), 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 spent fuel made of highly enriched uranium dioxide 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 CO_2, 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 was designed as a wet-storage facility) hold a total of 3 448 Mg HM of spent fuel (key date of 31 December 2010).

The on-site interim storage facilities, which are designed as dry-storage facilities, hold 2 678 Mg HM and 92 Mg HM in the form of LWR spent fuel assemblies which are stored in storage casks in the central interim storage facilities at Ahaus and Gorleben. 583 Mg HM of WWER fuel from Rheinsberg and Greifswald is likewise stored in transport and storage casks at the interim storage facility "*Zwischenlager Nord*" (ZLN) at Lubmin near Greifswald. A total of 6 686 Mg HM of spent fuel 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 spent fuel.

At the key date of 31 December 2010, a total of about 13 470 Mg HM had been generated in the form of spent fuel from the operation of the 17 operating and twelve decommissioned German light water reactors with capacities of > 50 MW, around 375 Mg HM of which had been generated in 2010 (cf. Table D-2). A part of the spent fuel located in the spent fuel pools has not yet reached its final burn-up and is 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 spent fuel intended for re-use is counted among the spent fuel in the amounts given in this report (e.g. in Table D-2 and Table D-3).

Table D-2: Quantities of spent fuel produced in light water reactors (capacity of > 50 MW) in the Federal Republic of Germany until 31 December 2010

Type	Abbr.	Power plant, site	Total quantity	
			Number	[Mg HM]
BWR	KKB	Brunsbüttel	2 132	371
BWR	KKK	Krümmel	3 081	546
PWR	KBR	Brokdorf	1 124	608
PWR	KKU	Unterweser	1 524	818
PWR	KWG	Grohnde	1 280	693
PWR	KKE	Emsland	1 156	622
PWR	KWBA	Biblis A	1 483	793
PWR	KWBB	Biblis B	1 631	873
BWR	KKP1	Philippsburg 1	3 040	542
PWR	KKP2	Philippsburg 2	1 256	678
PWR	GKN1	Neckarwestheim 1	1 653	591
PWR	GKN2	Neckarwestheim 2	1 032	552
BWR	KRB-B	Gundremmingen B	4 124	719
BWR	KRB-C	Gundremmingen C	4 001	695
BWR	KKI1	Isar 1	3 480	620
PWR	KKI2	Isar 2	1 076	575
PWR	KKG	Grafenrheinfeld	1 412	758
Subtotal:			**34 485**	**11 054**
Decommissioned plants:				
SWR	KWL	Lingen	586	66
SWR	KRB-A	Gundremmingen A	1 028	125
SWR	KWW	Würgassen	1 989	346
DWR	KMK	Mülheim-Kärlich	209	96
DWR	KWO	Obrigheim	1 235	352
DWR	KKS	Stade	1 517	539
DWR	KKR	Rheinsberg	918	106
DWR	KGR 1-4	Greifswald 1-5	6 813	787
Subtotal			**14 295**	**2 417**
Total:			**48 780**	**13 471**

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

Table D-3: Overview of total quantities of spent fuel from German light water reactors (capacity > 50 MW) up to 31 December 2010

Place of storage/whereabouts	Total quantity [Mg HM]
Spent LWR fuel in spent fuel pools at nuclear power plants (incl. wet storage facility outside KWO reactor building)	3 448
Dry storage of spent WWER fuel in casks at ZLN	583
Dry storage in casks at nuclear power plant sites	2 678
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	85
Reprocessed at the EUROCHEMIC reprocessing plant (Belgium)	14
Returned to the former UdSSR (WWER fuel)	283
Shipped permanently to Sweden (CLAB)	17
Reuse of WWER fuel at Paks (Hungary)	27
Total	**13 471**

Note: The quantities given in Mg HM have been rounded to the nearest number. This may result in minor differences compared to 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 thereby incurred.

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

Reactor	Quantities stored or disposed of [in Mg HM] at									Total
	WAK	BNFL	SKB	CEA	EURO-CHEMIC	FZ Jülich	TBL Ahaus	ZLN	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**	**46.3**	**7.4**	**1.8**	**6.9**	**1.9**	**0.3**	**186.6**

Most of the spent fuel listed in Table D-4 was reprocessed at WAK Karlsruhe, at BNFL or at EUROCHEMIC in Belgium. A smaller part of that 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 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. In September 2009, an application was filed for a licence to store the AVR fuel that is packaged in 152 transport and storage casks of the type CASTOR® THTR/AVR and currently stored at the AVR storage facility at Jülich, in the Transport Cask Storage Facility Ahaus. The proper waste management of the spent fuel from prototype reactors has thereby been ensured.

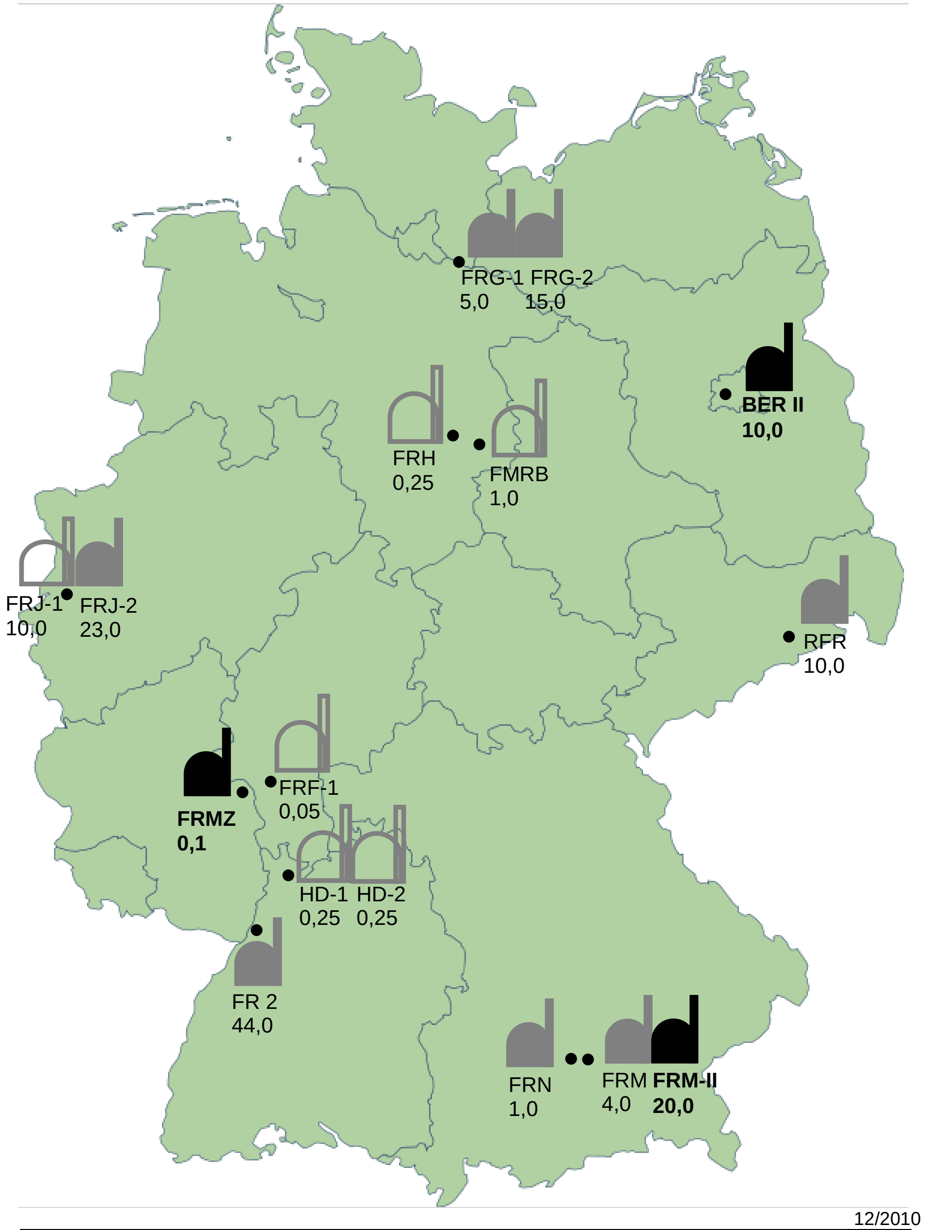
Research reactors

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

- one material test reactor (BER-II, Berlin),
- one high-flux reactor (FRM II, Munich),
- one TRIGA reactor at Mainz,
- four training/educational reactors, including three Siemens educational reactors (SUR) and one training reactor (AKR-2).
- Further two SUR (Aachen and Hanover) are without nuclear fuel and out of operation, a decommissioning licence has not yet been granted.

The geographical location of the research reactors with > 50 kW thermal output in Germany is shown in Figure D-8.

Figure D-8: Research reactors with > 50 kW thermal output in Germany



Legend

in operation Shut down completely dismantled

BER: Berliner Experimentier-Reaktor
FMRG: Forschungs- und Messreaktor Braunschweig
FR 2: Forschungsreaktor 2, Karlsruhe
FRF: Forschungsreaktor Frankfurt
FRG: Forschungsreaktor Geesthacht
FRH: Forschungsreaktor Hannover
FRJ: Forschungsreaktor Jülich
FRM: Forschungsreaktor München
FRN: Forschungsreaktor Neuherberg
FRMZ: Forschungsreaktor Mainz
HD: Forschungsreaktor Heidelberg
RFR: Rossendorfer Forschungsreaktor

Figures: Thermal power [MW]

The Jülich research reactor (FRJ-2) was finally shut down on 2 May 2006 and is currently in the post-operational phase. A research reactor in Geesthacht (FRG-2) has been partly removed, but the formal decommissioning is currently not possible, as this is a part of the common facility FRG-1 (common reactor pool) which was finally shut down on 28 June 2010. Furthermore, eight reactors with thermal output in excess of 1 MW have been shut down and are in varying stages of decommissioning. Three Siemens educational reactors (SUR) and one training reactor still have a valid operating licence. These three SUR reactors (Stuttgart, Ulm and Furtwangen) are intended to continue operation in the longer run for educational purposes. 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 was still approx. 0.8 Mg of spent fuel from these reactors waiting for disposal. Approx. 2.3 Mg spent fuel of the VKTA Rossendorf is stored in 18 CASTOR® MTR 2 casks at Ahaus.

It is intended to dispose of the spent fuel from BER-II und FRMZ as well as from the already shut-down MTR facilities in 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 there be no prolongation of this time window for shipping the waste to the US, then the spent fuel of the TRIGA reactor at Mainz which according to current plans is to remain in operation at least until 2020 will be put in central interim storage at Ahaus. As for the FRM II research reactor, the current legal situation obstructs the path to the USA. Its spent fuel will therefore also be emplaced in the interim storage at Ahaus with the aim of its disposal. The conversion of the FRM II fuel from highly enriched uranium (93 % U-235) to lower enrichments is, according to current state, planned for 2018.

In the 1960s and 1970s 12 Siemens educational reactors in FRG and - based on their model - one training reactor (AKR) in the former GDR were installed. The SUR reactors are so called zero-output reactors (thermal output 100 mW), which were operated with < 20 % enriched uranium dioxide dispersed in polyethylene. The SUR core consisted of 8-10 fuel plates. The SUR reactors in Stuttgart, Ulm and Furtwangen as well as the training reactor in Dresden are to continue operation.

From 2003 to 2007 a conditioning procedure was developed at the Institute for Radiochemistry of the Technische Universität München, where the polyethylene of the SUR fuel plates were incinerated without changing the nuclear fuel (< 20 % enriched Uranium dioxide) chemically. After blending to a U-235 enrichment of approx. 4.9 %, a further treatment in connection with the fabrication of spent fuel for power reactors can take place. Cores of all decommissioned SUR were incinerated at the Institute for Radiochemistry of Munich; the uranium was blended to a lower enrichment and was treated further in connection with the fabrication of spent fuel.

D.2.2. Activity inventory

The activity of the spent fuel (reference date: 31 December 2010) 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 spent fuel is divided into different categories on the basis of age: for the spent fuel assemblies unloaded prior to 1998, the assumed mean burn-up is 40 GWd/Mg HM, whilst for the unloaded between 1999 and 2006, the mean burn-up is defined as 50 GWd/Mg HM. A minimum decay period of one year for the last unloading is assumed. The data taken as bases were determined by an approved burn-up programme.

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

- Inventory of spent fuel stored in NPP cooling ponds (corresponding to 3 448 Mg HM) $1.5 \cdot 10^{20}$ Bq
- Spent fuel in casks and interim storage facilities (corresponding to 3 352 Mg HM) $6.5 \cdot 10^{19}$ Bq

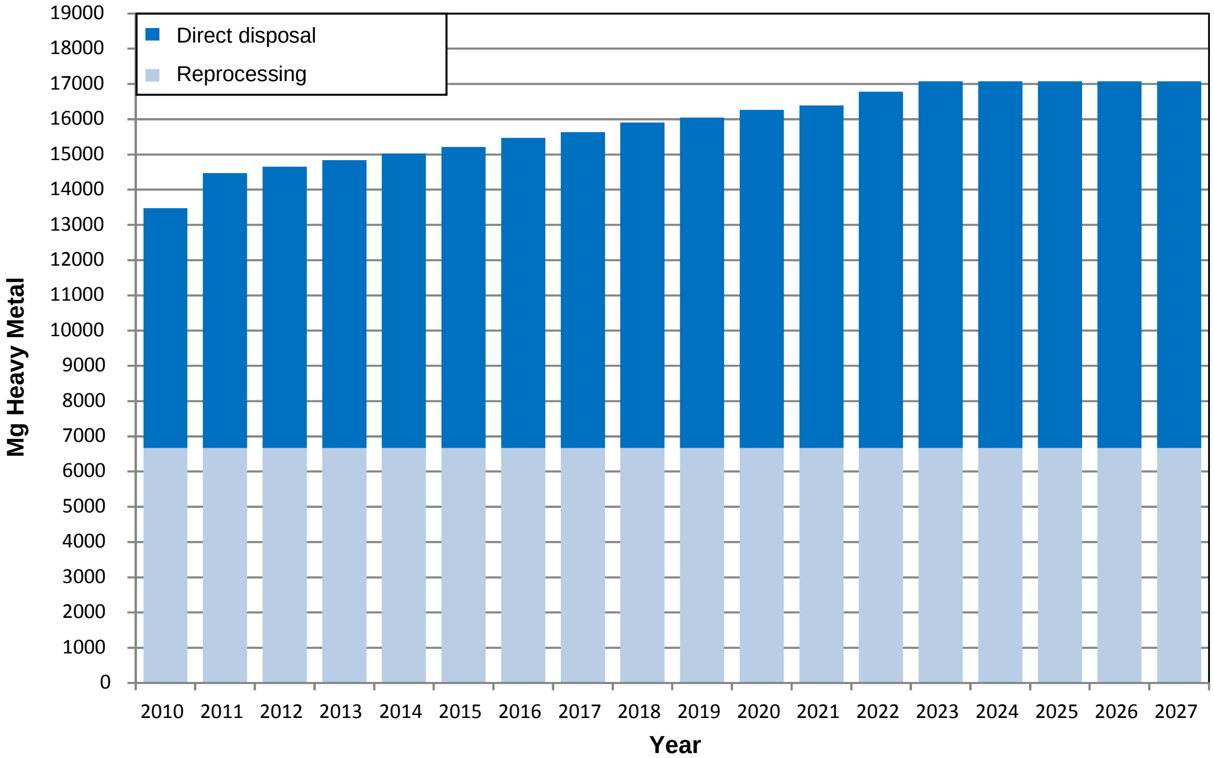
Thus, the total activity of all spent fuel currently in storage as per the reference date is approximately $2.1 \cdot 10^{20}$ Bq.

D.2.3. Predicted amounts

The energy utilities inform the respective competent regulatory authorities every year about the amounts of spent fuel probably generated from each nuclear power plant until their final closure. Under defined boundary conditions of the 13th amendment to the Atomic Energy Act of 30 June 2011 decided by the *Deutscher Bundestag*, it follows that from 1 January 2011 until the final closure of all plants, about another 4 000 Mg HM (including rest cores) of spent fuel will be generated. Together with the spent fuel that has already arisen until 31 December 2010, this amounts to a total of around 17 000 Mg HM, of which around 10 400 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 reprocessing abroad.

The projected time history of the future generated spent fuel is shown in Figure D-9.

Figure D-9: Cumulated generated spent fuel



D.3. Facilities for the treatment of radioactive waste

D.3.1. Conditioning plants

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 generated in the Federal Republic of Germany and must be intermediately stored until the repository is commissioned. There are two aims of conditioning; first, the reduction of volume in view of the limited interim storage and repository volume and second, the fulfilment of the interim storage and repository conditions. To achieve them, the waste product has to be stable (or fixed) and inert to avoid a chemical reaction in the form of gas formation caused by e.g. digestion and fermentation processes, therefore the waste product must not contain any free liquid. Conditioning, which comprises the treatment and/or the packaging of radioactive waste, may start with raw waste - possibly pre-treated - which has been specifically collected and sorted, or with an interim product. Conditioning processes which have been tested over many years are applied for various types of waste. The broad spectrum of the material properties is reflected by numerous conditioning processes:

- 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.

Conditioning of radioactive waste may take place in mobile or stationary facilities. Frequently used stationary waste conditioning facilities are decontamination and dismantling facilities, drying facilities, evaporator facilities, high-pressure compaction facilities, melting facilities and cementing facilities, which are located in Braunschweig, Duisburg, Jülich, Karlsruhe, Krefeld and Lubmin near Greifswald and that are also available for the processing of waste from external waste producers. The facility in Duisburg (cf. Figure D-10) with a controlled area of 6 500 m^2 provides the opportunity for maintenance, and if required, for conversion of the conditioning facility.

Figure D-10: Industrial premises Duisburg of GNS (Copyright: GNS)

The requirements mentioned in the acceptance criteria for the Konrad repository differentiate between waste products, waste containers and waste packages (consisting of waste product and waste container). 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-11).

Figure D-11: Examples of standardised waste containers
(left: Konrad-Container, right: cast iron container) (Copyright: GNS)

In order to prepare for disposal of low or medium-active waste an adequate availability of the conditioning facility with appropriate technical equipment is required to ensure duly conditioning or after-conditioning and acceptance of waste in the Konrad repository (acceptance is expected as of 2019). The aim is to provide a waste package volume of approximately 10 000 m^3, as common for Konrad, each year. The utilities aspire an increase of the hitherto conditioning capacities by extension of the existing facilities, including building work for waste conditioning. Gorleben, for example, plans an extension of the existing Interim Waste Storage Facility (ALG) (cf. Figure D-12). Furthermore, a possibility for preparation of operating and decommissioning waste until the transfer to the Konrad repository was given by creation of additional storage capacity in the Ahaus interim storage facility.

Figure D-12: Planned extension at the Gorleben Interim Waste Storage Facility (ALG) for housing of the technical installations necessary for increasing of the conditioning capacity. (Copyright: GNS)

Karlsruhe Vitrification Plant (VEK)

One major prerequisite for the complete dismantling of the Karlsruhe reprocessing plant (WAK) was the disposal of the liquid high-active waste concentrate (HAWC). This was a 60 m³ fission product solution from the first extraction cycle of the reprocessing which was stored in two containers in WAK, made a more complex plant management and impeded the dismantling.

The HAWC had 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, as this implies a minimisation of release potential as well as an approximately 2/3 reduction in volume. In 1999 – 2009 the Karlsruhe Vitrification Plant (VEK) was licenced, constructed, and initially taken into non-nuclear operation in five partial steps. In 2009 the commissioning and vitrification operations took place, and were finally finished in 2010. The vitrification procedure was examined in advance by the Product Control (*Produktkontrollstelle* - PKS) in Jülich on behalf of the Federal Office for Radiation Protection (BfS) and finally qualified by the BfS.

In VEK the HAWC, without pre-treatment, in liquid form was fed together with a boron-containing glass (a glass frit in pearl shape) into a directly heated ceramic melting furnace. The oxides, which were formed through chemical transformation after the evaporation of water and nitrates, were then bound at approximately 1 170 °C in molten glass in a deeper part of the melting furnace. After a fixed dwell time in the furnace the melt was filed by batch into 1.3 m high 150 l stainless steel canisters (four batches – one canister filling). After cooling down the canisters were seal-welded according to qualified procedures, decontaminated outside and emplaced into five transport and storage casks of the type CASTOR® HAW 20/28 CG.

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 non-nuclear operation of the VEK had 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 included the connection of the VEK to the HAWC storage areas of the WAK and the commissioning of the whole plant, first with HAWC surrogate (inactive trial operation), than with small quantities of HAWC with HAWC surrogate (active trial operation), and finally with pure HAWC (HAWC operation). The HAWC operation ran with just a few interruptions until June 2010. On 22 June 2010 the vitrification of the stored HAWC finished. Until that time 123 high active glass canisters were produced, 112 of which already were emplaced in four transport and storage casks of the type CASTOR® HAW 20/28 CG and located in the preparation for transport area ready for transportation. The remaining 11 canisters, together with the 17 glass canisters which were produced during the decontamination of the facility, were transferred in a fifth CASTOR® HAW 20/28 CG at the beginning of 2011. After this the vitrification system was decommissioned. The application for a licence for dismantling of the VEK according to § 7 para. 3 AtG [1A-3] is expected to be filed this year.

The total production of the VEK was estimated at 130 glass containers with a gross operating time of approximately 18 months. However, effectively the whole HAWC including decontamination solutions was vitrified in 15 months, whereby 149 glass canisters arose. Largely it was a failure-free operation. The few interruptions were the result of the following processes:

- purging of an orifice between the wet scrubber and the NO_x-Absorber for removal of deposits,
- exchange of a flue gas pipe of the furnace between the furnace and the wet scrubber for removal of deposits,
- remobilisation of deposits on precious metal at the oven outlet by installation of an air stirrer and emptying of the melting furnace.

As expected, deposits on the melting furnace arose, which made the purge of the melting furnace and wet scrubber, and also the repeated exchange of the flue gas pipe necessary. Also the deposits on precious metal at the bottom of the oven outlet led to an interruption of the operation. Due to an in time installation of an air stirrer the precious metal could have been remobilised and the furnace could continue its operation. Although these works were remote-controlled, the total interruptions in operation were only 2 % of the facility's life time.

From the end of September 2009 until the end of June 2010, 11 incidents of the category N according to the Nuclear Safety Officer and Reporting Ordinance (AtSMV) [1A-17] were reported which directly resulted from the VEK operation. All of these incidents, except one, were classified at level 0 according to the International Nuclear Event Scale (INES). The incident "Increased emission value after switching the exhaust gas filter at the LAVA" from 21 April 2010 led to a single exceeding of the admissible daily emission value for alpha and beta aerosols and did not result from the VEK operation. The resulting dose rate was negligible with regard to natural radiation exposure; subsequently, however, the event was upgraded from level 0 to level 1 according to the International Nuclear Event Scale (INES).

From July 2010 the post operational phase began comprising the following steps:

- repeated purging of the both LAVA storage tanks with a total of 20 m^3 acid solution,
- repeated purging of installations/components in the LAVA,
- providing evidence of the purging performance by sampling and dose rate measurements in the tanks,
- vitrification of purge solutions from the LAVA melting furnace, partly after concentration in the evaporator facility and addition of chemicals (for adherence of the guarantee values of the canisters,
- vitrification of solids from the flue gas pipe of the furnace,
- complete emptying and repeated purging of installations/components in the VEK,
- vitrification of the solutions from the emptying or purging of installations/components in the VEK in the melting furnace, partly after concentration in the evaporator facility and addition of chemicals (for adherence of the guarantee values of the canisters),
- vitrification of the last purging solution from installations/components of the VEK,
- complete emptying of the melting furnace.

During the decontamination programme, continued until 25 November 2010, a further 17 HAW glass canisters were produced and were transferred, together with the 11 canisters, from the HAWC operation, in the fifth CASTOR® cask. On 26 November 2010 the vitrification system was shut-down again. The VEK facility, as well as the rest of the WAK, will be completely dismantled; the application for a licence for remote-controlled dismantling will be filed in 2011. The five loaded CASTOR® casks were transported by rail to the interim storage facility "*Zwischenlager Nord*" (ZLN) in February 2011 where they will be stored until their disposal.

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 stored in interim storage facilities that have to be constructed and operated by the facility operator according to the polluter-pays principle. Apart from the interim storage of radioactive residues, another aim of interim storage is the radioactive decay of the waste to allow an 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 Storage Facility Ahaus (the duration of interim storage is limited to ten years from the first emplacement of a waste package), the Gorleben Interim Waste Storage Facility (ALG), and the Transport Cask Storage Facility Gorleben (TBL-G), in which storage capacity shall be provided within the context of a licencing procedure according to § 6 AtG [1A-3], covering the extent of other radioactive material under § 7 of the Radiation Protection Ordinance, the interim storage building of the energy utilities at Mitterteich, the interim storage facilities of the Nuclear + Cargo Service GmbH (NCS) company in Hanau, the interim storage facility "*Zwischenlager Nord*" (ZLN) near Greifswald, the interim storage facility Rossendorf (ZLR), 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 at Greifswald and Rheinsberg currently in the process of decommissioning may be brought to the interim storage facility "*Zwischenlager Nord*" (ZLN), and mainly waste originating from operation and decommissioning of facilities at the Karlsruhe site and decommissioning waste 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 at 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 Eckert & Ziegler Nuclitec 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 at the Gorleben Interim Storage Facility, in the interim storage building of the energy utilities at Mitterteich or in the interim storage facility of NCS at 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 II mine

Research activities in the repository field began after the take-over of the Asse II mine by the *Gesellschaft für Strahlenforschung* (GSF) on behalf of the Federal Government. Asse II is located in a former salt mine near Wolfenbüttel (Lower Saxony). Here, low-level and medium-level waste was disposed of from 1967 until the end of 1978. After that, the mine was only used for research and development purposes for repository projects without further emplacement of radioactive waste. In 1992, the research activities were ended. In order to stabilise the mine, old chambers were backfilled in 1995.

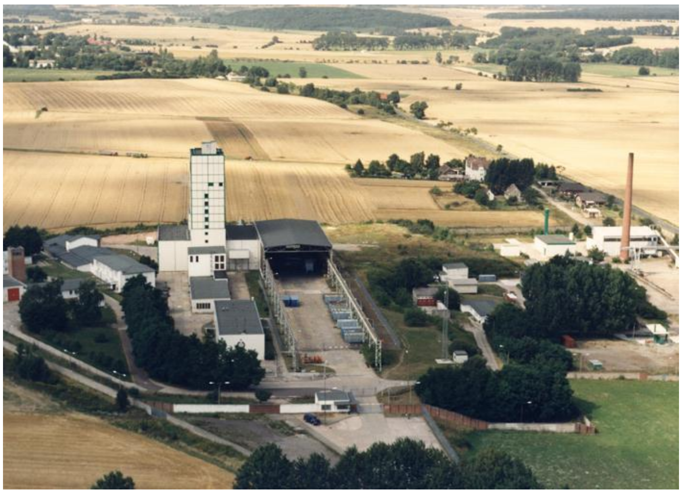
Since 1 January 2009, the Federal Office for Radiation Protection (BfS) has been the operator of the repository mine Asse II. This was preceded by the decision of the Federal Government of 5 November 2008 to transfer the Asse II mine, which had so far been operated according to mining law, to the area of application of nuclear law and to operate it in future as a radioactive waste repository according to § 9a of the Atomic Energy Act (AtG) [1A-3]. The BfS was charged with taking over the facility on 1 January 2009 from Helmholtz Zentrum München – *Deutsches Forschungszentrum für Gesundheit und Umwelt* (HMGU), and with operating and decommissioning it according to the provisions applying to repositories. As an administrative assistant to the BfS, the federally owned Asse-GmbH was founded who is operating the mine on behalf of the BfS.

Figure D-13: Repository Asse II mine (left: chamber during emplacement, right: dropping point (cf. the remarks made in Chapter H.6.9)) (Copyright: BfS)

Morsleben Repository for Radioactive Waste (ERAM)

In former GDR, the Morsleben repository for radioactive waste (ERAM) in Saxony-Anhalt was available since the first test emplacement in 1971 for the 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. Now the ERAM will be decommissioned. Corresponding design documents of the operator of the repository (BfS) were submitted to the licencing authority by the end of January 2009. After the public announcement on 15 October 2009 and the beginning of the design on 22 October 2009 the involvement of the public within the licencing procedure “decommissioning of ERAM” was initiated. The public display took place at the licencing authority (MLU), on-site at the association of administrations Erxleben and accordingly in the city hall of Helmstedt until 21 December 2009. In accordance with the declaration of design suitability the licencing authority determined the general feasibility of the project. The MLU plans to carry out the public hearing in the period from 13 October until 10 November 2011. BfS made the procedure documents publicly available on the internet. Parallel to the involvement of the public into the plan approval procedure further plans for decommissioning of the ERAM are made e.g. an in-situ test for a sealing structure in the rock salt.

Figure D-14: Repository for radioactive waste Morsleben (ERAM) (left: aerial photograph, right: emplacement chamber with stacked drums 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 granted 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; these works are on-going. More than 500 auxiliary conditions have to be observed and already existing design documents have to be revised for the retrofitting. Due to the advanced time since the plan approval notice further modification licences concerning conventional building permits have to be obtained. 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. The total costs for the Konrad repository comprise the costs for planning and exploration (1997 to 2008), an amount of approximately € 1 000 million, and the costs for project of the construction, according to first concrete calculations, an amount of € 1 600 million. The higher costs, compared to prior estimates, are particularly due to entrepreneurial conditions (e.g. changing market situation, cost increases in certain areas), as well as to ancillary provisions of the plan approval, technical standards (DIN, energy saving regulation), general price increases, wage or salary changes and value added tax increase.

At the Konrad repository site preparatory measures like detection of explosive ordnance and removal of industrially contaminated soil were carried out. Construction site facilities were built and the planned demolition of old buildings was carried out. First buildings (underground media duct, foundations of new buildings) were constructed (cf. Figure D-15).

The ecological restoration of the mines has been carried out successfully and the driving of underground mine workings and the first emplacement chambers has started.

Vehicles for underground working processes were procured and transported to the underground. Further comprehensive awarding procedures were prepared and a Europe-wide tender procedure was initiated.

Figure D-15: Konrad repository in Salzgitter (left: underground media duct, right: basement of the building of the hoisting machine) (Copyright: BfS)

The construction procedures of the Konrad repository also comprise the adaptation of the waste acceptance requirements for disposal for the Konrad repository. These are in particular the consideration of waste specific collateral clauses from the plan approval notice (PFB) and the increase of the radionuclide spectrum.

The waste specific collateral clauses mentioned in the mandatory part of the plan approval notice apply include in particular additional requirements for reliable maintenance of subcriticality (criticality safety), which led to additions to the basic requirements for waste products, declaration of radionuclides and the check of the compliance with the activity limitations for fissile materials.

Due to the extension of the knowledge about the radionuclides in radioactive waste with negligible heat generation, there are 156 radionuclides already considered, resulted from the safety analyses, now additional 82 radionuclides have to be taken into consideration. According to the experiences made these radionuclides arise erratically and with very small, often slightly radioactivity in individual waste packages or waste batches, this means they have no safety-related significance. According to this fact, corresponding tests and additions to the modified Konrad acceptance criteria of the repository were made [BfS 10].

A significant challenge is presented by the implementation of the ancillary provisions from the qualified legal water permission (Appendix 4 to the PFB Konrad). With the qualified legal water permission for repository of radioactive waste the BfS was granted the permit to dispose of radioactive waste with the contained non-radioactive damaging materials (substances of waste packages) in the Konrad repository, according to the provisions of the permission concerning the restrictions in compliance with two ancillary provisions mentioned. This permission serves to protect the near-surface groundwater.

The fulfilment of this basic idea is achieved in the course of the preparation of a comprehensive list of materials which is completed by a list of containers. This material and container list contains necessary information about the material properties and the composition of the waste packages disposed at the Konrad repository. In particular, this list contains the exact material and container terms or descriptions, specifications of waste and container material, manufacturer information, as well as information about the proportions of non-radioactive damaging components and values for description of the material composition (description values) and also for registration and balancing of non-radioactive damaging components (declaration values). After the approval by BfS and the agreement by the competent water authority (*Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz* (NLWKN)) the material vector/containers submitted by the waste producer are included in the materials or container list. The masses of non-radioactive damaging components emplaced are balanced by BfS for the facility's operating lifetime of the Konrad repository and for each year of operation. The procedure for implementing the ancillary provisions of the qualified legal water permission [BfS 10A] is approved by the competent authority (*Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz*) on 15 March 2011.

The description and declaration values for the 94 non-radioactive hazardous materials, according to the qualified legal water permission, were exemplary included into the continuously updated waste acceptance requirements for disposal.

In analogy to the waste acceptance requirements for disposal also the requirements for product controls of radioactive waste were supplemented. This was done in a separate report for the material product control, which contains strategy and implementing measures for the material product control [BfS 10B].

The Konrad repository may only accept German radioactive waste with negligible heat generation and a maximum waste package volume of 303 000 m^3. 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. the remarks to Chapter H.3.2). The aboveground exploration of the maiden salt dome began in 1997. A step-wise study programme initially concentrated on the examination of the hydro-geological 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 disposal of heat-generating radioactive waste began in 1986 with the sinking of the shafts down to a depth of about 800 m. In 1995, the driving of 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 1 500 million € have been invested so far in exploring the Gorleben salt dome and keeping the mine open.

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 disposal in salt rock as compared to other host rock formations. 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. The geological findings obtained until the start of the moratorium do not contradict a potential suitability of the Gorleben salt dome.

After the expiry of the 10-year moratorium at Gorleben, the underground exploration work was resumed in October 2010. In parallel, a preliminary safety analysis for the salt dome/the exploration mine is being in progress. The assessments on the preliminary safety analysis are to be performed in accordance with the “Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste” of the BMU of 30 September 2010 (cf. details in Chapter G.7). The results of this preliminary safety analysis will be subjected to an international peer review process in 2013. The decision on further actions will be taken on the basis of the resulting knowledge and assessments of the salt dome.

Figure D-16: Exploratory mine Gorleben; in the background: TBL-G, ALG and PKA (Copyright: GNS)

D.4. Inventory of radioactive waste

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

- the operation of nuclear power plants and research reactors,
- uranium enrichment and the production of spent fuel (nuclear industry),
- the decommissioning and dismantling of nuclear power plants, of prototype and demonstration installations, research 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 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 (France), and Sellafield Ltd., held by NDA (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 completed in 2011 according to plan, the return delivery of radioactive waste from the United Kingdom is currently still at the planning stage. The return of the first six casks of type CASTOR® HAW 28M is thus planned for 2014.

- Further contracts were concluded with the United Kingdom (UKAEA) to reprocess a limited number of spent fuel from research reactors. Spent fuel from German research reactors (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 2010 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 II mine is also provided.

D.4.1. Inventory of radioactive waste 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 2010 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 (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 2010

Type of residue	With negligible heat generation [m³]	Heat-generating [m³]
Untreated waste (raw waste residues yet to be recycled)	17 515	3
Interim products	10 295	1 251
Conditioned waste	96 513	593

Waste with negligible heat generation

In total, 17 515 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 10 295 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 96 513 m³ as per 31 December 2010. 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 2010

Waste producer group	Untreated primary waste [m³]	Interim products [m³]	Conditioned waste [m³]
Research institutions	6 110	3 785	40 025
Nuclear industry	393	1 439	7 909
Nuclear power plants	3 863	2 559	16 675
Decommissioned nuclear power plants	4 976	2 014	14 255
Land collecting facilities	1 194	205	3 424
Others	335	293	0
Reprocessing (WAK)	644	0	14 225
Total	**17 515**	**10 295**	**96 513**

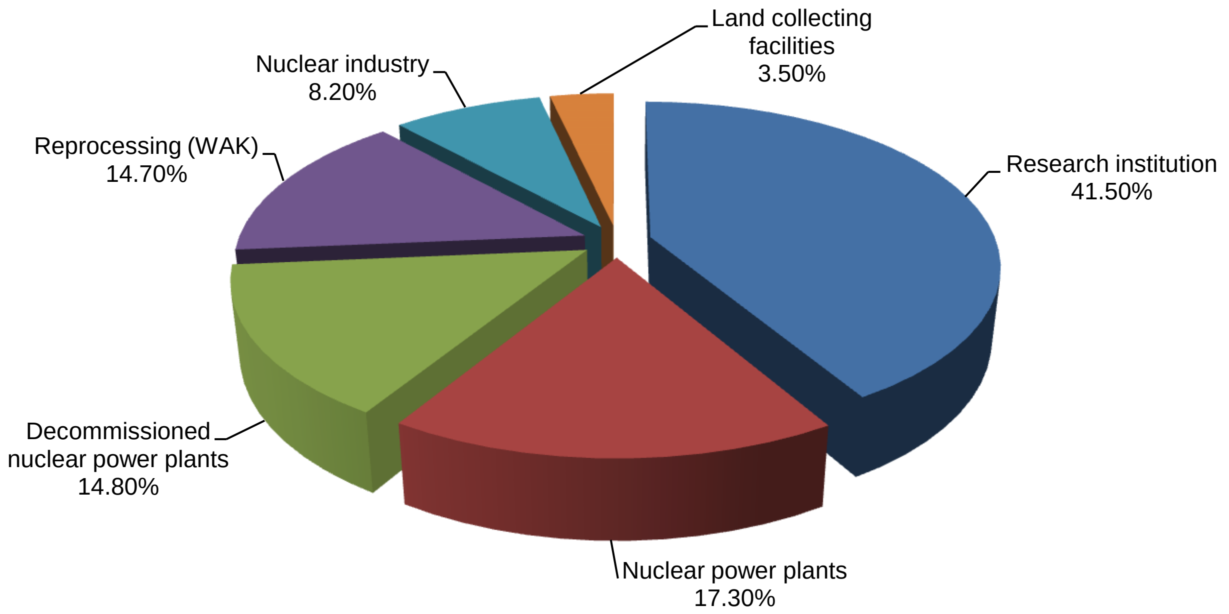
Table D-7 shows the distribution of the inventory of the conditioned waste with negligible heat generation, cumulated at the end of 2010, among the different interim storage options.

Table D-7: Interim storage of conditioned waste with negligible heat generation as per 31 December 2010

Interim storage facility	Waste volume [m³]
Research centres including clients	55 830
Nuclear industry	728
Energiewerke Nord, "*Zwischenlager Nord*"	4 034
Nuclear power plants	9 210
Land collecting facilities	2 653
Interim storage facility at the Unterweser nuclear power plant	1 208
Interim storage facility of the utilities at Mitterteich	6 373
GNS Gorleben Interim Waste Storage Facility (ALG)	6 631
NCS	7 110
GNS and other interim storage facilities	1 507
interim storage facilities at Ahaus (TBL-A)	76
interim storage facility at Stade Nuclear Power Plant	1 153

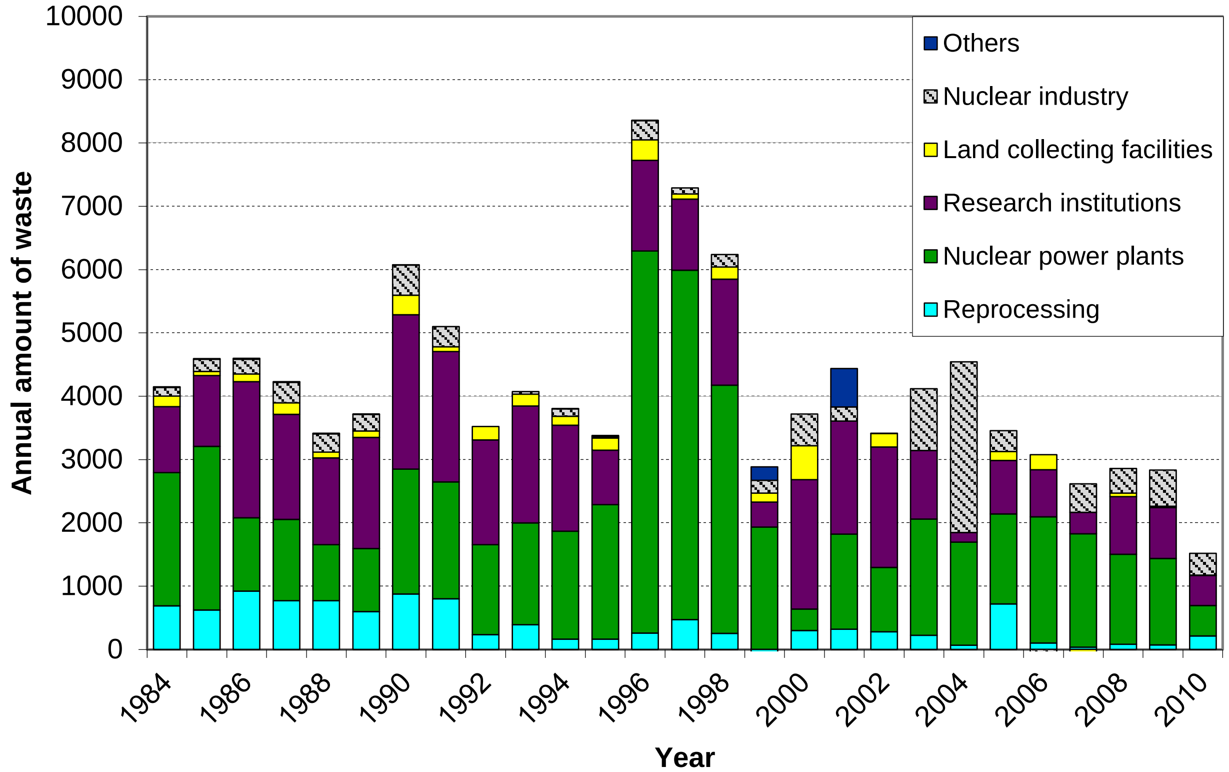
Figure D-17 shows the distribution of the inventory of the conditioned waste with negligible heat generation cumulated by the end of 2010 among the different waste producers.

Figure D-17: Distribution of the inventory of the conditioned waste with negligible heat generation as per 31 December 2010, total volume: 96 513 m³



The average annual amount of conditioned waste with negligible heat generation totals approx. 4 050 m³. Figure D-18 shows the annual amount of conditioned waste with negligible heat generation.

Figure D-18: Annual amount of conditioned radioactive waste in Germany since 1984



There was an increasing in waste conditioning between 1995 and 1998, as the radioactive waste could be shipped to the repository Morsleben (ERAM). Thus there was an increase in the amount of conditioned waste in these years. At the same time the inventory of conditioned waste in the interim storage facilities could be reduced or did not increase. Since the termination of emplacement operations in the ERAM, the amount of conditioned radioactive waste was significantly lower and there was again an 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. 3 m^3 of heat-generating primary waste, 1 251 m^3 of interim products and 673 m^3 of heat-generating conditioned waste stored in the Federal Republic of Germany as per 31 December 2010. As interim products the spherical fuel assemblies of the THTR Hamm-Uentrop were reported, that are in storage at the interim storage facility at Ahaus. The spherical fuel assemblies unloaded from the THTR are to be disposed of in a repository.

The largest part of the conditioned heat-generating waste comes from reprocessing. The reconditioned waste from reprocessing is enclosed in 97 casks (one Type TS 28 V cask and 85 casks of the CASTOR® type and 11 casks of Type TN85) holding a total of 2 716 canisters with vitrified fission product concentrate from the reprocessing of spent fuel at AREVA NC. In the years 2009 and 2010 the liquid fission product concentrate from WAK was vitrified. The produced casks are stored since February2011 in 5 transport and storage casks Type CASTOR® HAW 20/28 CG in the interim storage facility "*Zwischenlager Nord*" (ZLN) at Greifswald. The other heat-generating radioactive waste consists generally of activated components and spent fuel 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 2010

Waste producer group	Untreated primary waste [m³]	Interim products [m³]	Conditioned waste [m³]
Research institutions	3	0	85
Nuclear industry	0	0	0
Nuclear power plants	0	0	0
Decommissioned nuclear power plants	0	1 251	0
Land collecting facilities	0	0	20
Others	0	0	0
Reprocessing (WAK and abroad)	0	0	568
Total	**3**	**1 251**	**673**

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.

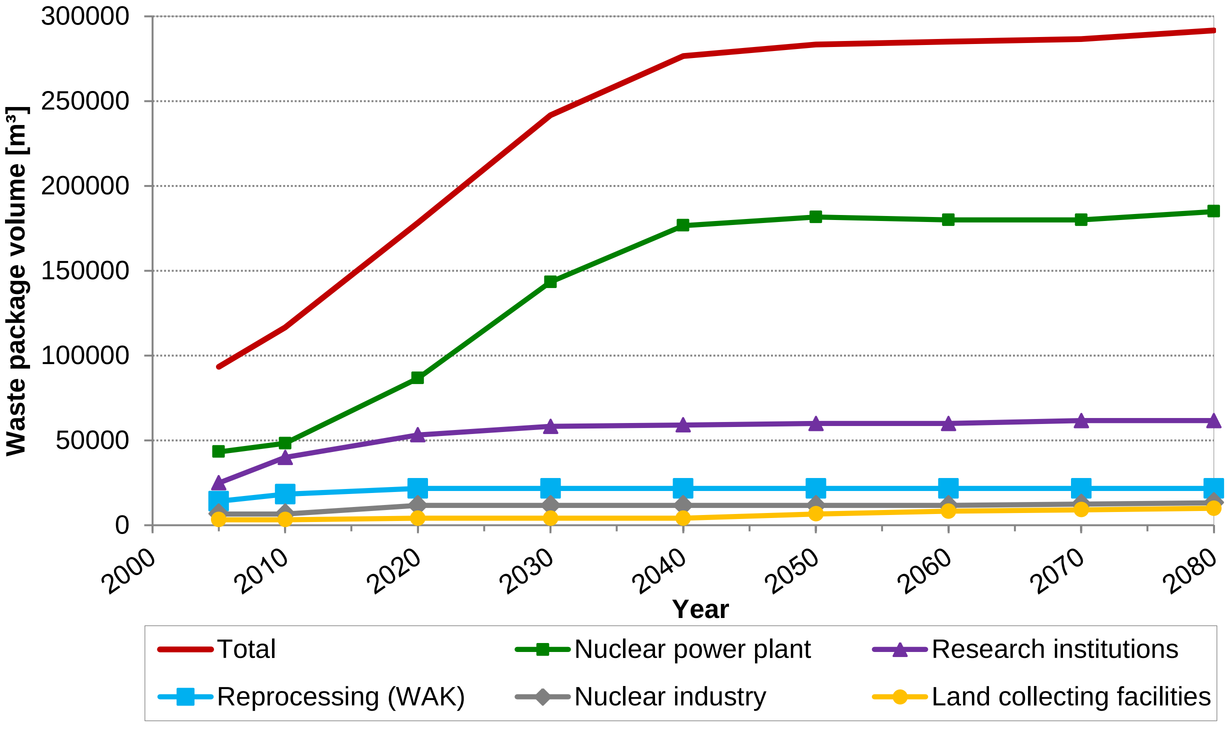
Prognoses

Regarding the work involved in planning a repository, it is necessary to make predictions of the waste generated in future 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 m^3 per annum. During a transitional phase of four years from operation until decommissioning, the licencing 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 m^3 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 waste generated in future expected by the waste producers is modelled in Figure D-19.

Figure D-19: Time-dependent accumulation of radioactive waste to be generated in future with negligible heat generation as waste package volumes in m^3 until the year 2080



It can be seen from this illustration that no further large amounts of waste are to be expected after 2040.

As already mentioned in Chapter D.2, approx. 13 470 Mg HM of spent fuel had been generated in Germany until 31 December 2010. Until all NPPs will have been decommissioned, a total of approx. 17 000 Mg HM will arise. Taking the already disposed of amounts (reprocessing) into account, the estimate is that there will be a total of approx. 10 400 Mg HM intended for direct disposal in a repository.

The cumulated amount of heat-generating waste in the year 2080, under defined boundary conditions of the 13th amendment to the Atomic Energy Act of 30 June 2011 decided by the *Deutscher Bundestag*, is estimated at a total of approx. 28 000 m^3 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. 20 400 m^3 of packaged spent fuel from light water reactors for disposal (this estimate is based on the assumption of disposal in POLLUX casks as present reference concept),
- approx. 770 m^3 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. 920 m^3 of structural parts and sleeves (CSD-C) from the reprocessing of spent fuel in foreign (France) reprocessing plants and from the WAK,
- approx. 2 000 m^3 of packaged spent fuel from the THTR and the AVR (disposal in 457 CASTOR THTR/AVR casks),
- approx. 180 m^3 of packaged spent fuel 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 m^3 of waste packages from the PKA with structural parts of the spent fuel that will go to disposal.

D.4.2. Disposed 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 m^3 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 l each and one 280-l drum containing Ra-226 waste are intermediately stored. Within the scope of the licencing procedure for the decommissioning, an application was submitted to dispose of this intermediately stored waste.

The waste from nuclear power plants primarily refers to waste generated 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 uncompacted 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 2010.

Table D-9: Radionuclide inventory of relevant radionuclides in the ERAM repository as at 31 December 2010

Radionuclide	Activity [Bq]	Radionuclide	Activity [Bq]
H-3	$2.3\cdot10^{12}$	Th-230	$1.8\cdot10^{6}$
C-14	$3.2\cdot10^{12}$	Th-232	$5.8\cdot10^{6}$
Cl-36	$3.9\cdot10^{9}$	Pa-231	$1.7\ 10^{6}$
Ca-41	$7.3\cdot10^{7}$	U-233	$5.0\cdot10^{6}$
Co-60	$7.9\cdot10^{12}$	U-234	$1.1\cdot10^{9}$
Ni-59	$1.8\cdot10^{11}$	U-235	$8.2\cdot10^{7}$
Ni-63	$1.4\cdot10^{13}$	U-236	$4.8\cdot10^{7}$
Se-79	$1.9\cdot10^{8}$	U-238	$4.3\cdot10^{8}$
Rb-87	$2.8\cdot10^{7}$	Np-237	$8.3\cdot10^{7}$
Sr-90	$5.1\cdot10^{12}$	Pu-239	$6.9\cdot10^{10}$
Zr-93	$9.3\cdot10^{9}$	Pu-240	$6.6\cdot10^{10}$
Nb-94	$2.7\cdot10^{10}$	Pu-241	$1.0\cdot10^{12}$
Mo-93	$2.5\cdot10^{8}$	Pu-242	$9.9\cdot10^{7}$
Tc-99	$1.0\cdot10^{11}$	Pu-244	$2.1\cdot10^{4}$
Pd-107	$6.7\cdot10^{7}$	Am-241	$2.3\cdot10^{11}$
Sn-126	$2.4\cdot10^{8}$	Am-243	$9.5\cdot10^{7}$
I-129	$2.1\cdot10^{8}$	Cm-244	$5.3\cdot10^{9}$
Cs-135	$3.7\cdot10^{8}$	Cm-245	$2.3\cdot10^{6}$
Cs-137	$6.7\cdot10^{13}$	Cm-246	$2.6\cdot10^{6}$
Sm-151	$2.7\cdot10^{11}$	Cm-247	$2.6\cdot10^{4}$
Ra-226	$3.9\cdot10^{11}$	Cm-248	$2.2\cdot10^{7}$
Th-229	$4.5\cdot10^{5}$		

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: Volumes emplaced in the Morsleben repository (ERAM) according to individual waste producers

Waste producer	Volume [m³]
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 II mine

In 1967, the emplacement of low-level waste, without additional shielding, in 1972, medium-level waste followed. For transport and storage of medium-level waste an additional shielded cask was needed. In 1978, the limited emplacement licences expired, and research and development in the field of disposal was continued without any further emplacement of radioactive waste. Until then, a total of 47 000 m^3 of radioactive waste from the delivering parties had been emplaced in various different waste package types:

- 124 494 waste packages as low-level waste with a total activity of approx. $2.25 \cdot 10^{15}$ Bq (as at 31 December 2010), 15 000 of them the so called lost concrete shieldings (VBA) containing waste with higher activity. These represent approx. 80 % of the total activity in the Asse II 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 $5.5 \cdot 10^{14}$ Bq (as at 31 December 2010). These represent approx. 20 % of the total activity and are stored at the 511-m level. Additionally eight drums holding low-level waste are also stored there. These were emplaced for testing of a new shielded cask (E2).

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 II mine with regard to number and activity by delivering party (waste origin)

Delivering party (waste origin)	Waste packages [%]	Total activity [%]
Karlsruhe Institute for Technology (KIT)	49	93
Jülich Research Centre (FZJ)	10	1
Nuclear power plants	25	2
Other delivering parties	16	4
Total	**100**	**100**

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

The low-active 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 are given in Table D-12 for LAW and MAW. No high-level waste was emplaced in the Asse II mine. Eight drums filled with intermediate level waste from FZJ contain parts of new and irradiated fuel rod segments or AVR fuel with, in some cases, with enriched uranium.

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

Kind of waste	LAW packages [%]	MAW packages [%]
Filter, filter aids, sludges, evaporator concentrates, resins,…	30	35
Metals, scrap, 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**

At that time no national or international waste classification for emplacement of waste existed. LAW (low active waste), MAW (medium active waste) and HAW (high active waste) were classified mainly against the background of waste handling. Essential for this was the dose rate at the cask surface and at a distance of one meter. The activity inventory served only as a rough guide. Though the total activity of LAW could have been up to approx. 2.7 Ci/m³ (10^{11} Bq/m³) and MAW from approx. 0.27 Ci/m³ (10^{10} Bq/m³) up to approx. 27 000 Ci/m³ (10^{15} Bq/m³). Waste was classified as HAW with a total activity from approx. 2 700 Ci/m³ (10^{14} Bq/m³), that, because of its heat generation, made a forced-air cooling necessary.

According to the acceptance criteria for the emplacement of LAW in the Asse II mine the dose rate at the cask surface of $\leq$ 200 mrem/h (2 mSv/h) and at a distance of one meter of $\leq$ 10 mrem/h (0.1 mSv/h) was specified, although in exceptional cases higher rates were admissible. Depending on the type of waste and packaging, the activity inventory could have been up to 25 Ci (10^{12} Bq) for casks in concrete shielding. Due to the concrete shielding as a part of the waste package the dose rate at the cask surface has been reduced to an extent that no additional shielding was needed for transport and therefore it was classified as LAW.

The mean activity for MAW, depending on the type of waste, was limited to 2 000 Ci/drum (approx. $7 \cdot 10^{13}$ Bq/drum) due to the acceptance criteria of 1971. In 1976 this limitation was reduced to 500 Ci/drum (approx. $2 \cdot 10^{13}$ Bq/drum). The basis for the above mentioned number of the LAW and MAW packages were the former acceptance criteria.

According to the current classification wastes are defined as LAW, if their handling and transport do not require additional shielding. MAW are wastes that require additional shielding, but are not considered as HAW. HAW are characterised by high concentrations of short-lived and long-lived radionuclides, typically in the range of $5 \cdot 10^{16}$ Bq/m³ to $5 \cdot 10^{17}$ Bq/m³. The significant heat generation is a further characteristic of HAW. Such wastes were not emplaced.

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 approx. $1{\cdot}10^{16}$ 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 II mine as per 31 December 2010. At that time, the total activity was approx. $2.8{\cdot}10^{15}$ Bq including an alpha activity of approx. $3.9{\cdot}10^{14}$ Bq.

Table D-13: Radionuclide inventory of relevant radionuclides in the Asse II mine as per 31 December2010

Radionuclide	Activity [Bq]	Radionuclide	Activity [Bq]
H-3	$6.5{\cdot}10^{12}$	Ra-226	$2.0{\cdot}10^{11}$
C-14	$3.0{\cdot}10^{12}$	Th-232	$3.3{\cdot}10^{11}$
Cl-36	$7.2{\cdot}10^{9}$	U-234	$1.4{\cdot}10^{12}$
Co-60	$1.6{\cdot}10^{13}$	U-235	$5.3{\cdot}10^{10}$
Ni-59	$1.8{\cdot}10^{12}$	U-236	$2.4{\cdot}10^{10}$
Ni-63	$2.6{\cdot}10^{14}$	U-238	$1.3{\cdot}10^{12}$
Se-79	$3.4{\cdot}10^{9}$	Np-237	$3.5{\cdot}10^{9}$
Sr-90	$2.1{\cdot}10^{14}$	Pu-239	$4.4{\cdot}10^{13}$
Zr-93	$5.5{\cdot}10^{11}$	Pu-240	$4.9{\cdot}10^{13}$
Nb-94	$1.8{\cdot}10^{11}$	Pu-241	$1.5{\cdot}10^{15}$
Tc-99	$1.1{\cdot}10^{11}$	Pu-242	$9.0{\cdot}10^{10}$
Sn-126	$4.6{\cdot}10^{9}$	Am-241	$2.3{\cdot}10^{14}$
I-129	$2.7{\cdot}10^{8}$	Cm-244	$9.0{\cdot}10^{11}$
Cs-135	$3.2{\cdot}10^{9}$	Cm-245	$2.7{\cdot}10^{8}$
Cs-137	$3.8{\cdot}10^{14}$	Cm-246	$3.3{\cdot}10^{8}$
Sm-151	$3.4{\cdot}10^{12}$		

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 disposal (cf. the remarks on Article 32 (2) iv b)).

Measures related to former practices are 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) [1A-3] 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
Power reactors (incl. prototype reactors)	16 reactors	3 reactors
Research reactors ≥ 1 MW thermal power (incl. ship Otto Hahn)	9 reactors	1 reactor
Research reactors < 1 MW thermal power	3 reactors	25 reactors 1 reactor rededicated
Fuel cycle facilities (primarily commercial production and reprocessing of spent fuel)	2 facilities	4 facilities
Research and prototype facilities of the nuclear fuel cycle	-	3 facilities

D.5.2. Power reactors

The 16 power reactors which are currently in the process of decommissioning include six prototype and demonstration reactors, as well as the nuclear power plants at Greifswald (KGR), Rheinsberg (KKR), Würgassen (KWW), Mülheim-Kärlich (KMK), Stade (KKS) and Obrigheim (KWO). On 17 May 2010, unrestricted clearance of the site and clearance of the building structures for conventional demolition were issued to the Kahl Experimental Nuclear Power Plant (VAK).The conventional demolition has been completed on 24 September 2010. The site has been cleared for unrestricted use. In addition, the nuclear power plants at Niederaichbach (KKN) and Großwelzheim (HDR) have been fully dismantled and the sites have been cleared for unrestricted use.

D.5.3. Research reactors

Nine research reactors with a thermal output of 1 MW or more are in various stages of decommissioning (including the FRG-1 that was finally shut down on 28 June 2010 as well as the FMRB Braunschweig that, except of one interim storage facility, was released from nuclear regulatory control), one reactor (FRJ) has been fully dismantled and released from nuclear regulatory control.

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 power reactors for educational purposes. One facility (AKR-1) was rebuilt and rededicated as a new educational reactor (AKR-2). For another facility, decommissioning is planned.

D.5.4. Fuel cycle facilities

The six commercial 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 in Karlstein has been converted to conventional use. At the NUKEM-A site, a facility for groundwater remediation remains in operation, which is the reason that the site has not yet been released from nuclear regulatory control.

Additional non-commercial fuel cycle facilities located at research centres have also been fully dismantled. The facility Siemens Power Generation Karlstein (SPGK) - a research facility with hot cells – and a facility for extraction of Mo-99 (AMOR) at Rossendorf, which are not considered part of the fuel cycle facilities, are currently in the process of decommissioning.

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 1970s (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 construction. Apart from the reactor units, the complex also comprises 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 licence was granted on 30 June 1995.

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 licencing steps. Decommissioning of KKR has to be seen in direct context with KGR, as the radioactive waste, the reactor pressure vessel and a major part of the material eligible for clearance are treated or stored at the facilities at the KGR site, mainly the interim storage facility “*Zwischenlager Nord*” (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.

A vital part of the overall concept for decommissioning has been the construction of the interim storage facility “*Zwischenlager Nord*” (ZLN) at the KGR site. The spent fuel from the cooling ponds in the reactor buildings and from the central fuel storage facility, ZAB, as well as from the nuclear power plant at Rheinsberg (KKR) has 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 apart 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 ZLN also serves for acceptance of casks with vitrified fission product solutions from the Karlsruhe Vitrification plant (VEK). 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 decoupled from the dismantling of the rest of the plant.

Since the last Review Meeting the following progress in the process of decommissioning of KGR and KKR was made:

- The interim storage facility for spent fuel (ZAB) has been fully dismantled and the area has been cleared according to § 29 StrlSchV [1A-8].
- Parts of the site that are no longer required have been cleared (if necessary after decontamination) for industrial or commercial purposes in order to develop the site. This process continues.
- The dismantling of the storage facility (ALfR) at the KKR site has been completed to a large extent. The dismantling of the specific water treatment plant of KKR has also been completed. In the reactor building the dismantling continues according to plan.
- The large components emplaced in ZLN, especially the steam generator, are segmented by different successive sawing procedures, cf. Figure D-20.

Figure D-20: Segmentation of a steam generator by sawing procedures in ZLN (Copyright: EWN)

At present, the final decision on the strategy for clearance of the KGR site is prepared. A proposal of EWN including the following issues is currently under discussion:

- to completely remove the buildings of the controlled area in a timely manner,
- to subject them to a detailed radiological characterisation in order to demonstrate compliance with the so called restoration values,
- to keep them subsequently in the long term (approx. 50 years) in an upright position for efficient use of the radioactive decay and
- after this period of time, taking into account the results of the radiological characterisation, to subject them to clearance for demolition.

Advantages of this approach are that the subsequent (conventional) use of the turbine hall, which is closely linked to the reactor buildings, as well as the use of the rest of the area can continue undisturbed and that the efficient use of the radioactive decay in compliance with the protection objectives significantly facilitates later clearance of the buildings.

Obrigheim nuclear power plant (KWO)

The Obrigheim nuclear power plant (KWO), a pressurised water reactor with an electrical power rating of 357 MWe (gross), started operation in 1968. 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*.

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. The decommissioning strategy that has been chosen for KWO is early dismantling. Decommissioning and dismantling of the facility have to be carried out under four licences according to § 7, para. 3 of the Atom Energy Act (AtG) [1A-3]. The decommissioning strategy is, however, influenced by a number of site-specific factors, of which storage of spent fuel 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. Application for a storage licence 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.

The first decommissioning and dismantling licence was issued on 28 August 2008; the second application has been made on 15 December 2008. The parts to be dismantled are in particular the components of the controlled area, e.g. both steam generators, the pressuriser with the pressurizing system and pressuriser relief tank, the reactor coolant pumps, the reactor coolant line and the safety injection system.

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, 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, para. 3 of the Atomic Energy Act (AtG) [1A-3]. 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.

Measurements for clearance of the remaining building structures of the controlled area, especially the multi-purpose hall and the radwaste building, were completed in May 2009.

The unrestricted release of the whole site and the clearance of the buildings for conventional demolition were issued on 17 May 2010. The conventional demolition of the building structures was completed on 24 September 2010. The site has been cleared for an unrestricted use.

Figure D-21: The successive dismantling of the reactor building of the Kahl experimental nuclear power plant to the green-field
(Copyright: NUKEM, BMU, RWE Power)

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.

Direct decommissioning was chosen as the decommissioning option. Dismantling was separated into six phases, whereby the conventional demolishing of the buildings is the last phase. The licence according to the Atomic Energy Act [1A-3] for the first decommissioning phase was issued on 14 April 1997; the fourth and last licence for the fourth and fifth decommissioning phases was issued on 6 September 2002.

With completion of dismantling of the reactor building and concrete structures in the area of the containment the relevant milestones regarding the full dismantling of the plant were achieved according to plan. Currently, in the main buildings, the final dismantling of the residual installations and systems as well as the decontamination and clearance of the buildings is carried out.

Residual materials like scrap metal, building rubble etc. are generally decontaminated and are then subjected to a clearance procedure according to § 29 of the Radiation Protection Ordinance (StrlSchV) [1A-8], which ends with a final measurement on which the clearance decision is based.

Buildings and building areas are also subjected to a clearance procedure according to the Radiation Protection Ordinance (StrlSchV).

Radioactive waste from operation and decommissioning of KWW are stored in two storage buildings at the site until it can be dispatched to the Konrad repository.

The dismantling measures, according to the fourth decommissioning licence, are scheduled for completion at the end of 2014. Then a part of the site can be released from nuclear regulatory control and the corresponding buildings can be conventionally dismantled.

The remaining residual areas, including the operational interim storage facility for radioactive waste, will be released from nuclear regulatory control after removal of these wastes to the repository. Then the residual buildings at the site will be demolished conventionally.

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). The plant started operation in 1972 and was finally shut down on 14 November 2003. Early dismantling was chosen as decommissioning strategy. Dismantling was separated into five phases and the applications were filed with appropriate time lag between them. The final dismantling phase pertains to the conventional demolishing of the buildings at the site.

The first licence was issued on 7 September 2005 and referred to the decommissioning of the entire complex as well as the transition phase of the plant, the construction of an operational interim storage facility for radioactive waste, as well as the dismantling of the first components and systems. The fourth dismantling phase pertains to residual dismantling measures in preparation for the conventional demolishing. This licence was issued on 4 February 2011.

By the final removal of any residual fuel assemblies in April 2005, the absence of nuclear fuel was achieved. 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. Dismantling of the reactor pressure vessel was completed on time in October 2010.

Currently final dismantling measures are carried out in KKS with decontamination and clearance of buildings to follow subsequently. Residual materials like e.g. 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.

Buildings and building areas are also subjected to a clearance procedure according to the Radiation Protection Ordinance (StrlSchV).

Radioactive wastes from operation and decommissioning of KKS are stored in two storage buildings at the site until it can be dispatched to the Konrad repository.

The dismantling measures, licenced under atomic law, are scheduled for completion at the end of 2014. Then the site, apart from an interim storage facility will be released from nuclear regulatory control and the corresponding buildings of KKS will be conventionally dismantled.

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 with separate licences. 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 advanced very far. The components and systems in the turbine hall and reactor building that are not required were dismantled. Segmentation of the reactor pressure vessel and the biological shield has been completed. The waste produced are emplaced in qualified packages and removed to the interim storage facility Mitterteich. The decontamination of the reactor building follows.

As the Gundremmingen site comprises two other nuclear power plants (Unit B/Unit C) with boiling-water reactors 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 and regulates the transition of these areas into the licence of the units B/C.

Under certain conditions the licence permits the handling of radioactive waste with the aim of clearance, conditioning of waste, maintenance of components, manufacturing and storage of tools and equipment as well as the storage and preparation for transport of conditioned and unconditioned waste until processing or shipment.

Mülheim-Kärlich nuclear power plant (KMK)

The Mülheim-Kärlich nuclear power plant (KMK), a pressurised water reactor with an electrical output of 1 302 MWe (gross); was finally shut down after only 13 months of operation in September 1988. Decommissioning of the plant was decided and the application for a licence for dismantling has been filed in June 2001. Decommissioning was separated into three separate stages. The first licence pertaining to decommissioning and phase 1 of dismantling was issued on 16 July 2004. With the shipping of the last spent fuel in 2002 the plant is free of nuclear fuel.

The first decommissioning work started in 2004. Currently, the controlled area and the annulus have been cleared. Also the main areas of the reactor auxiliary building have been emptied. The core flooding pool in the reactor building has been removed and the peripherals in the range of the steam generators have been removed. Currently the pressuriser is being dismantled.

The emphasis is placed on the replacement of the existing large-scale residual operating systems by versatile and mobile systems.

In the secondary area most of the buildings have been cleared, currently the turbine hall is being emptied.

Reduction of the surveillance area has started, so that it currently represents a third of its former size. Parallel to this a part of the site is already released from the purview of the Atom Energy Act.

The project Mülheim-Kärlich is aligned to the Konrad interim storage facility. The existing dedicated disposal space in external interim storage facilities are sufficient for the dismantling of the facility, except the reactor pressure vessel and the biological shield.

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 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 for developing the process. Following the decision in 1989 to halt the reprocessing of nuclear fuels in Germany and instead ship the spent fuel to reprocessing plants abroad, the continued operation of WAK and the construction of WAW became superfluous.

The uranium and plutonium that were separated during operation were used for the production of new spent fuel, whilst the separated high-level liquid waste was 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).

In the HAWC storage facilities there were still approx. 60 m^3 high-active liquid waste (HAWC) from the operational phase. An important precondition for the dismantling of the plant therefore was the vitrification of the HAWC and the shipping of the produced casks. The HAWC was duly conditioned in the Karlsruhe vitrification plant, built for this purpose, from September 2009 to June 2010.

The first licence for decommissioning was issued in 1993. 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, as until the completion of the vitrification most of the major operating components like e.g. HAWC storage facilities continued their operation and high local dose rates and contamination from alpha-emitting nuclides were present. The decommissioning strategy is planned in six steps, whereby much of the dismantling work at WAK is to be 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. As far as possible, the dose rate in specific areas of the plant was and is 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. Because of the presence of a broad spectrum of alpha emitting nuclides and fission products in varying proportions, completely different requirements are put on the clearance as during decommissioning of other fuel cycle facilities or reactor plants.

The dismantling of the former process building is far advanced. Preparing measures for dismantling of the cleared storage facilities and the VEK have started. Once it has been released from supervision under the Atomic Energy Act, the WAK will be demolished conventionally. The project is currently expected to be completed by the year 2023.

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 being 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.

The removal of the spherical fuel assemblies into the central interim storage facility within the grounds of the Research Centre Jülich was completed in June 1998.

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. In November 2008, the reactor pressure vessel was filled with low-weight aerated concrete, by which handling is facilitated and the radioactive inventory (internals and graphite dust) was 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-22). This annex, which is markedly higher than the old reactor building, will allow opening of the building structure of the reactor building by the end of 2011/beginning 2012 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 shall 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. Finally the reactor is to be transferred into the newly built interim storage facility at the research centre Jülich in close vicinity. The reactor vessel is to be stored there until the later conditioning for final storage.

Figure D-22: Annex of the transfer building to the reactor building AVR (Copyright: EWN)

Lingen nuclear power plant (KWL)

The shut-down Lingen nuclear power plant (KWL) was a boiling-water reactor with an electrical power of 252 MWe (gross). Operation started in 1968.

In 1977, based on technical considerations, the plant was finally shut down. After removal of the spent fuel, the *Kernkraftwerk Lingen GmbH*, 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 November 1985.

With a notice of 14 November 1997, KWL was granted the licence for modification of the plant, and the operation under safe enclosure conditions for the purposes of disposing of the operational waste. Although the management of radioactive waste could not be continued after closure of the ERAM, the work on the conditioning of the operational waste continued and has since been completed. The plant was continuously optimised regarding improvement of the occupational safety as well as the fire prevention and radiation protection. An application for the prolonging of the safe enclosure in 2004 was rejected after the legal validation of the commission of the Konrad repository; instead KWL applied for a licence for dismantling according to § 7, para. 3 Atomic Energy Act (AtG) [1A-3] in December 2008.

Currently the licencing documents to be submitted according to the Nuclear Licencing Procedure Ordinance (AtVfV) [1A-10] are examined by the experts of the atomic licencing authority. Dismantling is planned in two partial licences. First all planned measures were described and an application for dismantling of all contaminated and uncontaminated components was made. The second partial licence pertains to dismantling of active components, residual dismantling and decontamination with the aim of release of the plant from nuclear regulatory control, followed by the conventional demolishing of the residual buildings at the site.

The licence is not expected before 2013. Afterwards the infrastructure of the plant will be prepared for the dismantling. Then the systematic segmentation of contaminated components may start. The aim of the dismantling strategy is mainly directed to segmentation suitable for transport, and the handling and decontamination of material in external waste management facilities for minimising the waste volume. The low volume returned from waste conditioning may be prepared for transport to the Konrad repository in the controlled area, or stored in the Ahaus interim storage facility. Dismantling of active components will only start in dependence of the acceptance of waste of the Konrad repository.

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 assemblies from the reactor core and the dismantling of components was granted on 22 October 1993. The spherical fuel assemblies have been removed from the reactor core and transferred into the central interim storage facility at Ahaus in CASTOR® THTR/AVR 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.

After 20 years of operation under safe enclosure conditions (until 2017) the option whether, and if, how long the care and maintenance operation will continue is to be demonstrated to the supervisory authority under the Atomic Energy Act (AtG) [1A-3]. Existing concepts regarding the dismantling of the THTR-300 plant, developed by independent experts, are reviewed and if necessary updated regularly.

E. Legislative and regulatory system

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

Developments since the Third Review Meeting:

Since the report of the Third Review Conference, there were several changes in nuclear law.

With the amendment to the Atomic Energy Act of 17 March 2009, § 12b of the Atomic Energy Act was adapted to the security situation which has changed since the terrorist attacks of 11 September 2001 in the USA and further terrorist acts in the aftermath (London, Madrid) also regarding the hazards to nuclear installations and nuclear transports - in addition to other precautions already taken by the Government at national and international level.

With the amendment of 17 March 2009 it was stipulated, on the other hand, that for the operation and decommissioning of the Asse II mine in the future the provisions of the Atomic Energy Act on repositories of the Federation shall apply (§§ 23 and 57b AtG [1A-3]). The Federal Office for Radiation Protection as a new operator will be both responsible for the decommissioning of the Asse II mine in the context of a nuclear plan approval procedure in accordance with § 9b AtG and for continued operation of the installations until its decommissioning; the continued operation does not require the performance of a plan approval procedure.

With the 13th amendment to the Atomic Energy Act of 6 August 2011 as a consequence of the events in Japan, which led to a reassessment of the risks associated with the use of nuclear energy, the licences to operate the plants Biblis A and B, Neckarwestheim 1, Brunsbüttel, Isar 1, Unterweser, Philippsburg 1 and Krümmel expired. For the remaining nine nuclear power plants, the operating licences will expire between 2015 and the end of 2022 (see also Section A.3 "Political Development").

The 12th amendment to the Atomic Energy Act of 8 December 2010 primarily transposed the obligations under Council Directive 2009/71/EURATOM of the European Union establishing a Community framework for the nuclear safety of nuclear installations - unless they already represented applicable national law - into national law. The transposition concerned, among other issues, the obligations of owners of nuclear facilities to provide adequate human and financial resources as well as continuous basic and advanced training of personnel responsible for nuclear safety. In addition, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), competent for nuclear safety and radiation protection, will in the future conduct a self-assessment of the legal, regulatory and organisational framework every ten years.

Moreover, the twelfth amendment reintroduced, among other things, a possibility to access private rights of third parties in the Atomic Energy Act. The possibility of expropriation is to ensure that the legal mandate to construct installations for the disposal of radioactive waste can be fulfilled. In this way it is prevented that the refusal of only one private owner to open up to a necessary solution also serving common welfare can hinder the implementation of the statutory requirement of constructing a repository. Should attempts to reach an agreement fail, thus access possibilities and rights will be available in the form of expropriation provisions as a last resort.

Furthermore, the twelfth amendment introduces the obligation to conduct regular reviews and assessments of the safety of other nuclear installations, as e.g. local interim storage facilities. Up to now, this obligation has only been applicable to nuclear power plants.

The changes in the Nuclear Reliability Assessment Ordinance (AtZüV) (last amendment of 22 June 2010) [1A-19] result from the tenth amendment to the AtG of 17 March 2009.

The Nuclear Waste Shipment Ordinance (AtAV) [1A-18] was amended on 30 April 2009. It serves to implement Council Directive 2006/117/EURATOM of 20 November 2006 [EUR 06] on the supervision and control of shipments of radioactive waste and spent fuel.

The Nuclear Safety Officer and Reporting Ordinance (AtSMV) [1A-17] was amended by ordinance of 8 June 2010. The changes concerned, in particular, the reporting criteria. The amended AtSMV now contains, besides the already existing criteria catalogues for the obligation to report events at nuclear power plants, separate criteria catalogues for nuclear installations under decommissioning, for interim spent fuel storage facilities and research reactors. The amended AtSMV entered into force on 1 October 2010.

The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) has developed safety requirements governing the disposal of heat-generating radioactive waste. The safety requirements put the state of the art in science and technology in concrete terms that is to be complied regarding the construction, operation and closure of a repository for heat-generating waste and to be reviewed by the respective licencing authority within the plan approval procedure.

The draft of July 2009 is being further developed in dialogue with the *Länder* and is already binding for the BfS as the operator of all repositories in Germany.

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 licencing 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

Framework requirements due to the federal Structure of the Federal Republic of Germany

The Federal Republic of Germany is a Federal State. The 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.

The legislative competence for the use of nuclear energy for peaceful purposes lies with the Federation, Article 73 paragraph 1 No. 14 in conjunction with Article 71 of the Basic Law. The further development of nuclear law is also a task of the Federation. The *Länder* will be involved in the procedure dependent on the subject matter.

The Atomic Energy Act (AtG) [1A-3] and the statutory ordinances based thereon are implemented, according to §§ 22 – 24 AtG, by authorities of the Federation and the *Länder*, with many tasks related to the execution according to § 24, para. 1 AtG in conjunction with Articles 87c, 85 of the Basic Law performed by the *Länder* on behalf of the Federation. With respect to the lawfulness and appropriateness of their action, the competent *Land* authorities are subject to the oversight by the Federation.

Article 85 Basic Law

[Execution by the Länder on federal commission]

1. Where the *Länder* execute federal laws on federal commission, establishment of the authorities shall remain the concern of the *Länder*, except insofar as federal laws enacted with the consent of the *Bundesrat* otherwise provide.
2. The Federal Government, with the consent of the *Bundesrat*, may issue general administrative rules. It may provide for the uniform training of civil servants and other salaried public employees. The heads of intermediate authorities shall be appointed with its approval.
3. The *Land* authorities shall be subject to instructions from the competent highest federal authorities. Such instructions shall be addressed to the highest *Land* authorities unless the Federal Government considers the matter urgent. Implementation of the instructions shall be ensured by the highest *Land* authorities.
4. Federal oversight shall extend to the legality and appropriateness of execution. For this purpose the Federal Government may require the submission of reports and documents and send commissioners to all authorities.

The competent supervisory and licencing authorities report to the Federation on law enforcement on demand. The Federation has the right to require the submission of reports and documents 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. The competence of execution, i.e. the implementation of the decision towards the applicant or licencee, 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 licencing procedure.

In Germany, those concerned, e.g. applicants or licencees or also concerned third parties, 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 Article 19, para. 4of the Basic Law [GG 49]). Action is brought against the competent *Land* authority or the *Land* whose authority issued the administrative act. This is also applicable to the case that a *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 claim granting of licences applied for or the residents the issuance of an administrative order for cessation of operation of a nuclear installation.

Involvement of international and European law

International treaties

In the hierarchy of legislation, the international treaties concluded by the Federal Republic of Germany in accordance with Article 59 para 2 sentence 1 of the Basic Law [GG49] are on the same level as formal federal law.

As a matter of principle, rights and obligations under the treaty only apply to the Federal Republic of Germany as contracting party.

An overview of the most important international treaties of the Federal Republic of Germany in the fields of nuclear safety, radiation protection and liability, and on national implementing provisions is to be found in Annex [Agreements, General Provisions].

For Germany, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [1E-8] entered into force on 18 June 2001.

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 [1E-11],
- the Brussels Supplementary Convention of [1E-12], and
- the Joint Protocol of 21 September 1988 Relating to the Application of the Vienna Convention and the Paris Convention.

As one of currently 86 contracting parties, the Federal Republic of Germany joined-the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter of 1972 and ratified it in November 1977. The convention revised and adopted in amended form ("London Protocol") in 1996 which prohibits waste dumping at sea with a few exceptions, has also been ratified by the Federal Republic of Germany in October 1998. It entered into force on 24 March 2008.

A similar objective as of the London Convention is pursued by the OSPAR Convention of 1992, which entered into force in early 1998. It unites the Federal Republic of Germany and 14 other western and northern European countries and the European Union for the protection of the North-East Atlantic. The OSPAR Convention was established by the unification and expansion of the Oslo Convention of 1972 and the Paris Convention of 1974.

Legal provisions of the European Union

In Germany, legislation and administrative actions must take into account any binding requirement from regulations of the European Union. However, the EU law - with some exceptions – is not directly applied in the national nuclear licencing and supervisory procedures, but must first be transposed into national law within certain time limits.

In its Title II, the Treaty establishing the European Atomic Energy Community (EURATOM Treaty) contains provisions for the encouragement of progress in the field of nuclear energy. Chapter 3 of this title regulates the protection of health and thus opens up a specific area of competence for European legislation to the European Atomic Energy Community (EURATOM).

In accordance with Articles 77 et seq. 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.

In the field of radiation protection, EURATOM basic standards were laid down for the protection of the health of the general public and workers against the dangers arising from ionising radiations [1F-18] based on Articles 30 ff. (Health and Safety) of the EURATOM Treaty [1F-1]. Council Directive 96/29/EURATOM laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation [1F-18] of 1996 was transposed into national law by the Radiation Protection Ordinance (StrlSchV) [1A-8]. Currently, the Federal Republic of Germany participates in the drafting of the new EURATOM directive on basic safety standards ("EURATOM Basic Safety Standards"). The directive aims, on the one hand, at bringing together the existing five radiation protection guidelines of the European Union and, on the other hand, at an update of the existing EURATOM basic safety standards.

On 22 July 2009, the Council Directive 2009/71/EURATOM establishing a Community framework for the nuclear safety of nuclear installations [1F-5] entered into force to supplement the directives of the European Atomic Energy Community on radiation protection. Thus, for the first time, binding European regulations on nuclear safety had been established. The directive pursues the objective of maintaining and continuously improving nuclear safety. The Member States of the European Union are to take appropriate national measures to effectively protect workers and the general public against the dangers of ionising radiation from nuclear installations. The Directive applies, among others, to nuclear power plants, research reactors, and the storage of nuclear fuel if directly related to the respective nuclear installation and taking place on the same site, but not to repositories for radioactive waste. The Directive includes provisions regarding the establishment of a legislative and regulatory framework for nuclear safety, the organisation and functions of the nuclear regulatory authorities, the obligations of the operators of nuclear installations, on education and training of the staff of all parties involved, and on the information to the public.

The Directive maintains the national responsibility for nuclear safety by, among others, the fact that the Member States have the express right to take more stringent safety measures in addition to the provisions of the Directive in compliance with Community law (Article 2 para. 2 of the Directive).

With the establishment of a Community framework for nuclear safety, the European Commission addressed the management of spent fuel and radioactive waste as a further objective of harmonisation. According to the ideas of the European Commission common approaches and standards are now to be developed for the interim and final storage of irradiated spent fuel and radioactive waste, also taking account of safety aspects.

The European legislative process of the EURATOM Directive on the management of spent nuclear fuel and radioactive waste has not been finalised yet.

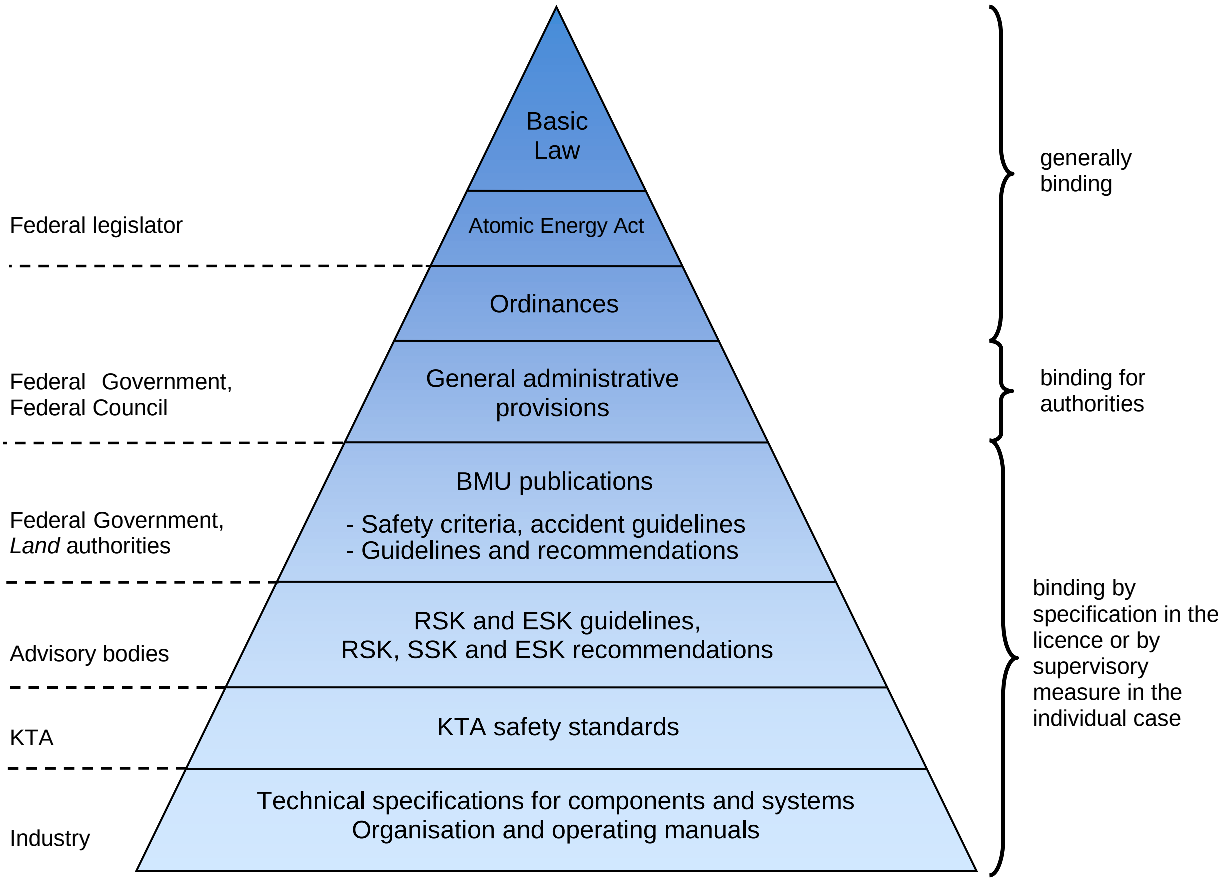
An overview of the legal provisions of the European Union, in particular with regard to radiation protection and radioactive waste, is to be found in Annex [Agreements, General Provisions].

E.2.2. National 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 not included in 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 referred to in the various nuclear licencing conditions (e.g. in § 7, para. 2, subpara. 3 AtG [1A-3]: *"A licence may only be granted if (…) the necessary precautions have been taken in the light of the state of the art of science and technology to prevent damage resulting from the erection and operation of the installation."*). According to legal practice, it can be presumed that the nuclear rules and regulations accurately reflect the state of the art. The dynamic improvement in safety requirements required by law is not bound by the formal development of standards. A substantiated scientific advancement will displace the application of an obsolete non-mandatory guidance instrument without explicitly needing to suspend it.

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 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 Federation.

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 licencing and supervisory procedures and have been further developed, where necessary, in line with the state of the art in science and technology.

Acts, statutory ordinances and administrative provisions

Basic Law

The Basic Law [GG 49] contains provisions on the legislative and administrative competencies of the Federation and the *Länder* regarding the use of nuclear energy. In addition, there are fundamental principles that also apply to the nuclear law.

With the basic rights, in particular the right to life and physical integrity, it determines the standard to be applied to the protective and preventive measures at nuclear facilities which is further specified in the above hierarchy levels of the pyramid. The principle of proportionality and guaranty of property, laid down in the Basic Law, must also be considered.

Formal federal law, 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 protective and precautionary measures, radiation protection and the management of radioactive waste and spent fuel 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 licencing. 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). The Atomic Energy Act provides that the Federation shall construct installations for the disposal of radioactive waste. The construction and operation of such an installation requires licencing in the form of a planning approval procedure. The necessary costs for the construction and operation of repositories shall be borne by the waste producers through contributions and fees according to §§ 21a and 21b AtG in conjunction with the Repository Prepayment Ordinance (EndlagerVlV).

However, most of the regulations provided in the Atomic Energy Act and due to the statutory ordinance promulgated on the basis of the Atomic Energy Act 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 non-mandatory guidance instruments.

The Atomic Energy Act concretely requires that certain activities are subject to licencing. So, for example, § 7 AtG stipulates that the construction, operation or the ownership of an 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 waste.

The Atomic Energy Act is supplemented by the Precautionary Radiation Protection Act of 1986 [1A-5], which was prompted by the Chernobyl disaster. It regulates governmental tasks regarding the monitoring of radioactivity in the environment as well as precautionary measures to limit radiation exposure of people and the radioactive contamination of the environment in the case of events with potential 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 construction and operation of federal installations for the disposal of radioactive waste and for licencing for the storage of nuclear fuels.

The 12th amendment to the Atomic Energy Act of 8 December 2010 transposed the obligations under Council Directive 2009/71/EURATOM of the European Union establishing a Community framework for the nuclear safety of nuclear installations - unless they already represented applicable national law - into national law.

Ordinances

For further concretisation of the legal regulations, the Atomic Energy Act includes authorisations for the promulgation of statutory ordinances (cf. the list in § 54, para. 1 AtG). 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 licencing procedure (Nuclear Licencing Procedure Ordinance) (AtVfV) [1A-10],
- the transboundary shipment of radioactive waste or spent fuel (Nuclear Waste Shipment Ordinance) (AtAV) [1A-18],
- advance payments for the construction of radioactive waste disposal facilities (Repository Prepayment Ordinance) (EndlagerVlV) [1A-13],
- provisions for sufficient coverage (Ordinance on the Financial Security Pursuant to the Atomic Energy Act) (AtDeckV) [1A-11].
- the reporting of reportable 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), Commission on Radiological Protection (SSK) and Nuclear Waste Management Commission (ESK), 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] and
- monitoring of fodder [2-6].

Announcements by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)

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 licencing and supervisory procedure (cf. the remarks on Article 20 of the Convention). They outline the opinion of the BMU and, in general, of the nuclear supervisory and licencing 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. 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 and radioactive waste can be found in Annex L-(d) [3-1] and following.

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

- the Safety Criteria for the Final Disposal of Radioactive Wastes in a Mine [3-13],
- the Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste [BMU 10],
- 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) [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 [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) [3-43-2].

The “Safety Criteria for the Final Disposal of Radioactive Wastes in a Mine” [3-13], published in the Federal Law Gazette at the beginning of 1983, had the task to concretise the requirement to take the necessary precautions pursuant to the Atomic Energy Act (AtG) [1-A3] also to be met for disposal. In the time following, international recommendations and standards on radiation protection and disposal of radioactive waste were substantially revised and updated according to new findings. Against this background, the BMU has developed the safety requirements for the disposal of heat-generating radioactive waste. The safety requirements put the state of the art in science and technology in concrete terms that is to be complied with regarding the construction, operation and closure of a repository for heat-generating waste and to be reviewed within the plan approval procedure by the respective licencing authority.

The “Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste” were approved by the *Länder* Committee for Nuclear Energy (LAA) on 30 September 2010.

Guidelines and recommendations of the RSK, SSK and ESK

The recommendations of the Reactor Safety Commission (RSK), the Commission on Radiological Protection (SSK) and the Nuclear Waste Management Commission (ESK), established on 12 June 2008, play an important role with respect to licencing and supervisory procedures. These independent expert commissions advise the Federal Environment Ministry for the Environment, Nature Conservation and Nuclear Safety on issues relating to nuclear safety, radiation protection and the management of radioactive waste and spent fuel. 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, SSK and ESK submit their results of consultations to the Ministry in the form of statements or recommendations which are prepared in committees and working groups. Via publication in the Federal Law 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 Requirements on the Interim Storage of Low and Intermediate Level Waste in the Longer Term” [4-3].

In 2010, the ESK adopted recommendations for guidelines for the performance of periodic safety reviews for interim storage facilities for irradiated fuel assemblies and heat-generating radioactive waste in casks [4-5]. The need for this arises from the safety reference levels of the Western European Nuclear Regulators Association (WENRA), to whose practical implementation Germany has committed itself as a WENRA Member State (see Chapter K.5), as well as from the requirements for the interim storage in Council Directive 2009/71/EURATOM establishing a Community framework for the nuclear safety of nuclear installations [1F-5]. For implementation, a two-year review phase is planned as a first step, during which the performance of a periodic safety review for two selected interim storage facilities will be tested.

KTA safety standards

The Nuclear Safety Standards Commission (KTA), founded in 1972, was established at the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). It is made up of the following five interest groups: representatives of the manufacturers, the plant operators, the federal and *Länder* authorities, the expert organisations and representatives of general concerns, e.g. of the unions, the industrial safety and the liability insurers.

The office of the KTA is affiliated to the Federal Office for Radiation Protection (BfS).

According § 2 of its statutes, the KTA has the task to establish safety standards and to promote their application in fields of nuclear technology where experience indicates that the experts representing the manufacturers and operators of nuclear installations, the expert organisations and the federal and *Länder* authorities would reach a uniform opinion. The regulations are prepared by experts of the interest groups meeting in working groups and are then adopted by the KTA. The five interest groups have an equal strength of ten representatives each. A safety standard requires a 5/6 majority to be adopted. Therefore, no individual interest group voting unanimously can be outvoted by the others.

The regulatory powers of the legislator and administrative action by the competent authorities are not restricted by the KTA process. It is possible to formulate necessary requirements, guidelines and recommendations and to implement them regardless of the consensual formulation of KTA safety standards.

Historically, the KTA safety standards have been developed on the basis of applicable German technical standards and regulations and on the American nuclear safety standards. The ASME-Code (Section III) was used as a model for specifying the requirements regarding the design and construction of components. The KTA safety standards contain detailed, concrete specifications of a technical nature. 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 91 safety standards already issued and three standard drafts; an additional 12 standard drafts are currently under preparation, and 50 safety standards are in the process of being revised [KTA 10].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.

In this respect, the requirements of the conventional technical standards are to be referred to as a minimum standard for nuclear systems and components. Moreover, Federal and *Länder* provisions relating to nuclear law shall not be affected to the extent that stricter or different requirements are made or permitted by them.

Other legal areas

When licencing 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 regarding the exploration of suitable repository sites and in the licencing procedure for repositories in deep geological formations:

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

E.2.3. Licencing system

With respect to protection against the hazards of radioactive materials and supervision of their utilisation, the Atomic Energy Act (AtG) [1A-3], as well as the Radiation Protection Ordinance (StrlSchV) [1A-8] in certain areas, requires that the construction and operation of nuclear installations as well as other facts or circumstances, such as the handling of radioactive material, are subject to regulatory licencing. The licencing requirement is stipulated in various provisions of the nuclear rules and regulations, depending on the type of installation and operation.

- § 7 AtG: The management of spent nuclear fuel and radioactive waste 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 in the cooling pond of the reactor and to the treatment and interim storage of operational waste. The pilot conditioning plant (PKA) at Gorleben likewise falls under the licencing requirement pursuant to § 7 AtG. Licencing 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 Federal Ministry of Finance or designated customs offices.
- § 6 AtG: The storage of nuclear fuel, including spent fuel and radioactive waste with significant contents of fissile material requires (if the proportion of certain uranium and plutonium isotopes exceed the limits specified § 2, para. 3 AtG) 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 containers at Gorleben and Ahaus. The licencing 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 [1A-3]: 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 licencing and supervision of the facility.
- § 9b AtG: The safekeeping and disposal of radioactive waste, which is the responsibility of the Federation 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 licencing 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 Federation 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 construction and operation of repositories are subject to Federal Government oversight.

- § 7 of the Radiation Protection Ordinance (StrlSchV) [1A-8]: The handling of radioactive waste (not applicable to nuclear fuels) 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 waste at research centres and conditioning facilities. Licencing 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 licencing 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 licencing system with regard to decommissioning is described in the details on Article 26.

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

Table E-1: Responsibilities relating to the licencing and supervision of nuclear installations and the handling of radioactive waste in the Federal Republic of Germany

Material	Activity	Legal basis	Licencing	Supervision/ oversight	Installations (examples)
Nuclear fuel and waste containing nuclear fuel	Construction and operation	§ 7 AtG	*Land* authority	*Land* authority	PKA, VEK
	Treatment or use	§ 9 AtG	*Land* authority	*Land* authority	Activities outside of installations governed by § 7 AtG (e.g. laboratory-scale handling of nuclear fuel for research purposes)
	Storage	§ 6 AtG	BfS	*Land* authority	Gorleben, Ahaus, on-site storage facilities
	Import and export	§ 3 AtG	BAFA	Federation	-
Other radioactive material acc. to § 2, para. 3 AtG (e.g. waste with low nuclear fuel content)	Handling, e.g. storage	§ 7 StrlSchV [1)]	*Land* authority (e.g. Trade Supervisory Office)	*Land* authority (e.g. Trade Supervisory Office)	Collecting facilities of the *Länder*, interim storage facilities, conditioning facilities
Radioactive waste	Disposal	§ 9b AtG	*Land* authority	Federation	Morsleben repository, Konrad repository

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 licencing 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) [1A-8]. The StrlSchV includes regulations on the designation of responsible individuals by the licencee 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 and the handling of radioactive waste without the necessary licence are offences liable to prosecution.

The licencing of nuclear installations (except for nuclear fuel storage facilities licenced by the BfS under § 6 AtG) is the responsibility of the respective *Länder*. In the *Länder,* ministries are the supreme authorities responsible for licencing according to the Atomic Energy Act (§§ 7 and 9 AtG) [1A-3], subordinate authorities (e.g. trade supervisory offices) are responsible for the granting of licences according to the Radiation Protection Ordinance (handling of radioactive waste, collecting facilities of the *Länder*). The Federation supervises implementation of the Atomic Energy Act and radiological protection regulations by the *Länder* (federal oversight). 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 licencing in accordance with § 7 AtG are specified in the Nuclear Licencing Procedure Ordinance (AtVfV) [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 licencing requirements (e.g. non-radioactive emissions into the air or discharges into water). The Nuclear Licencing Procedure Ordinance is also applied in the case of other nuclear licencing and plan approval procedures (according to §§ 6 or 9b AtG [1A-3]). The option of splitting the licencing 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 licencing 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 all technical or scientific matters related to regulatory licencing and supervision. 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 licencees are generally required to take out liability insurance policies for a maximum financial sum specified in the individual nuclear licencing procedure.

In the following, examples are given for the procedures according to §§ 6, 7 and 9b AtG.

In contrast to licences according to §§ 6, 7 AtG, construction and operation of repositories for radioactive waste are subject to a plan approval procedure according to § 9b AtG. This makes it clear that the plan approval procedure is a special type of procedure that is integrated into the environment, taking into account all public and private interests affected. Accordingly, the effects of approval, concentration, replacement, creation of a legal situation and toleration are characteristic for the plan approval decision.

As a central (plant) licencing provision of the Atomic Energy Act, special attention is to be paid to the licencing for stationary installations for the production or for the treatment or processing or for the fission of nuclear fuels or for the reprocessing of irradiated nuclear fuels as well as for decommissioning, safe enclosure and dismantling according to § 7 AtG. Since § 6 AtG does not represent a plant licence but a licence related to the practice of storage of nuclear fuel, this issue will be outlined below for differentiation and a better understanding.

Licence for the storage of nuclear fuel according to § 6 AtG

§ 6 AtG [1A-3] is not a plant licence, as are for example licences according to § 7 AtG, but a so-called activity-related licence. Here, the activity of "storage" of nuclear fuel is permitted, i.e. first of all its storage (in contrast to disposal according to § 9b AtG) at a particular location, but also activities necessary for it (e.g. taking over and preparation of casks, transportation to the cask position, maintenance work and other common operations). This storage does neither require a comprehensive nuclear construction and operation licence nor a formal plan approval procedure. For the construction of such a storage facility, the building laws of the respective *Länder* apply. The construction licence is to be limited regarding the use of the building insofar as it must not contain a final decision binding for third parties on the protection against nuclear-specific risks. This issue is subject to examination by the nuclear regulatory authorities responsible for it.

The licence according to § 6 AtG is a bound decision which means that it is to be granted without discretion if the conditions stated in § 6, para. 2 AtG are fulfilled. The corresponding conditions largely correspond to those of § 7, para. 2 AtG, with the exception of the "knowledge of persons involved" within the meaning of § 7, para. 2, subpara. 2 AtG, and the "conflict with overriding public interests" within the meaning of § 7, para. 2, subpara. 6 AtG.

The nuclear licencing procedure as illustrated by the example of the procedure according to § 7 AtG

According to § 7 AtG, construction, 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. A licence may only be granted if the licencing 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 licencing 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 (cf. details in Chapter E.2.2 on the hierarchical structure of the regulations). The Atomic Energy Act does not include specific regulations about the procedure for the assessment of such risks.

The actual details and procedure of licencing in accordance with the Atomic Energy Act are specified in the Nuclear Licencing Procedure Ordinance (AtVfV) [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 licencing steps (partial licences). It deals, furthermore, with the assessment of environmental impacts [1F-12] and with the consideration of other licencing 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 licencing authority of the *Land* in which the nuclear installation is to be constructed. 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 Licencing Procedure Ordinance (AtVfV) [1A-10]. The required format is further specified in guidelines.

§ 3 of the Nuclear Licencing Procedure Ordinance (AtVfV) defines the character and scope of the documents. It states that documents should be enclosed which allow verification of compliance with the licencing 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) [1A-3], i.e. precautions against damage caused by the construction 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) [1A-8] (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 Licencing Procedure 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 construction 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 waste until their disposal;
9. information on other environmental impacts of the project required for verification pursuant to § 7, para. 2, subpara. 6 AtG [1A-3] for any approval decisions included in the licencing decision in individual cases, or for any decisions to be made by the licencing 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 licencing 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 licencing 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 technical expert organisations to support the licencing 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 have no autonomous decision-making powers. The licencing authority assesses and decides on the basis of its own judgment. The authority is not bound by the findings of their authorised experts.

Within the framework of federal executive administration, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) may submit a statement from the point of view of federal oversight before the licence is granted. In performing its function of federal oversight, the BMU consults its advisory bodies, the Reactor Safety Commission (RSK), the Commission on Radiological Protection (SSK), the Nuclear Waste Management Commission (ESK), and in many cases the *Gesellschaft für Anlagen- und Reaktorsicherheit* (GRS), for advice and technical support. The *Land* licencing authority must take the BMU’s statement into account when making its decision.

Environmental Impact Assessment

The Environmental Impact Assessment Act [1B-14], in conjunction with the Atomic Energy Act and Nuclear Licencing Procedure Ordinance (AtVfV) [1A-10] based on it, regulate the need to conduct an environmental impact assessment and its procedure within the nuclear licencing procedure for the construction, operation and decommissioning of a nuclear installation to be licenced according to § 7 of the Atomic Energy Act (AtG) [1A-3] or for an essential modification of the facility or its operation. According to § 3, para. 2 of the Nuclear Licencing Procedure Ordinance, the following documents are to be included with the application additionally in the case of a project subject to an environmental impact assessment:

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 gaps.

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.

Participation of the general public

The licencing authority involves the general public in the licencing procedures, including in particular those citizens who might be affected by the planned facility. Details are regulated in the Nuclear Licencing Procedure Ordinance (AtVfV) [1A-10].

According to § 4 AtVfV, the project is published in the official Publication Gazette and in local newspapers once the documents to be submitted for public display 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 and – in the case of a project subject to an environmental impact assessment-information on radioactive residues and other environmental impacts of the project, as described under points 8 and 9 of § 3 AtVfV above, and the documents according to § 3, para. 2 AtVfV 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. It serves to discuss any objections that have been duly raised with the applicant and those having raised the objections, insofar as this may be important for an examination of the licencing requirements. Any individuals who have raised objections are to be given the opportunity to explain them.

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

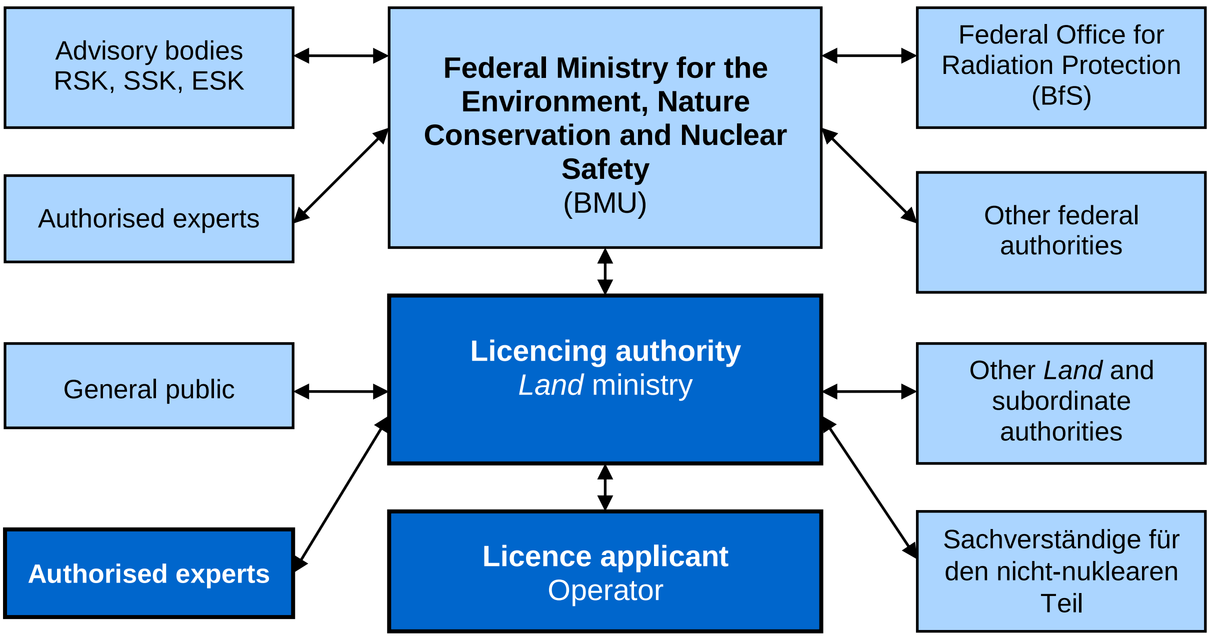
In case of material amendments to a nuclear licence, public participation may not be necessary if the modification applied has no adverse effects for the population.

Licencing decision

The final decision of the licencing 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 (BMU), 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 Licencing Procedure Ordinance (AtVfV) [1A-10] must have been observed. Action may be brought against the decision of the licencing 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 licencing 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 licencing procedure (using the procedure according to § 7 AtG as an example)



Plan approval procedure according to 9b AtG for installations for the safekeeping and disposal of radioactive waste

According to § 23, para. 1, subpara. 2 AtG [1A-3], the BfS is responsible for the construction and operation of facilities for the safekeeping and disposal of radioactive waste.

According to § 9b AtG, construction and operation of radioactive waste repositories require a special licence known as plan approval (*Planfeststellung*). 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 licencing procedures, the licence incorporates all the other licences required, e.g. under the terms of, building legislation or nature conservation legislation. Exceptions to this result from § 9b, para. 5, subpara. 3 AtG and the Federal Water Act. Accordingly, plan approval does not cover the legitimacy of the project under the provisions of mining law which requires other procedures. As far permits are required according to water legislation, they are also decided on separately according to § 19 of the Federal Water Act (WHG). Exceptions are decided on by the competent authority. Moreover, the plan approval procedure according to § 9b, para. 5, subpara. 1 AtG also includes involvement of the general public.

The plan approval notice may only be issued if the requirements referred to in § 7, para. 2, subparas 1 to 3 and 5 AtG (cf. details in Chapter E.2.3) are complied with. In addition, plan approval shall be denied if

- the construction 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 construction 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 licencing 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 Federation and the *Länder* are not obliged to make liability provisions.

The participants in a plan approval procedure and in repository supervision are summarised in Figure E-3 and Figure E-4.

Figure E-3: Parties involved in the nuclear plan approval procedure for a repository

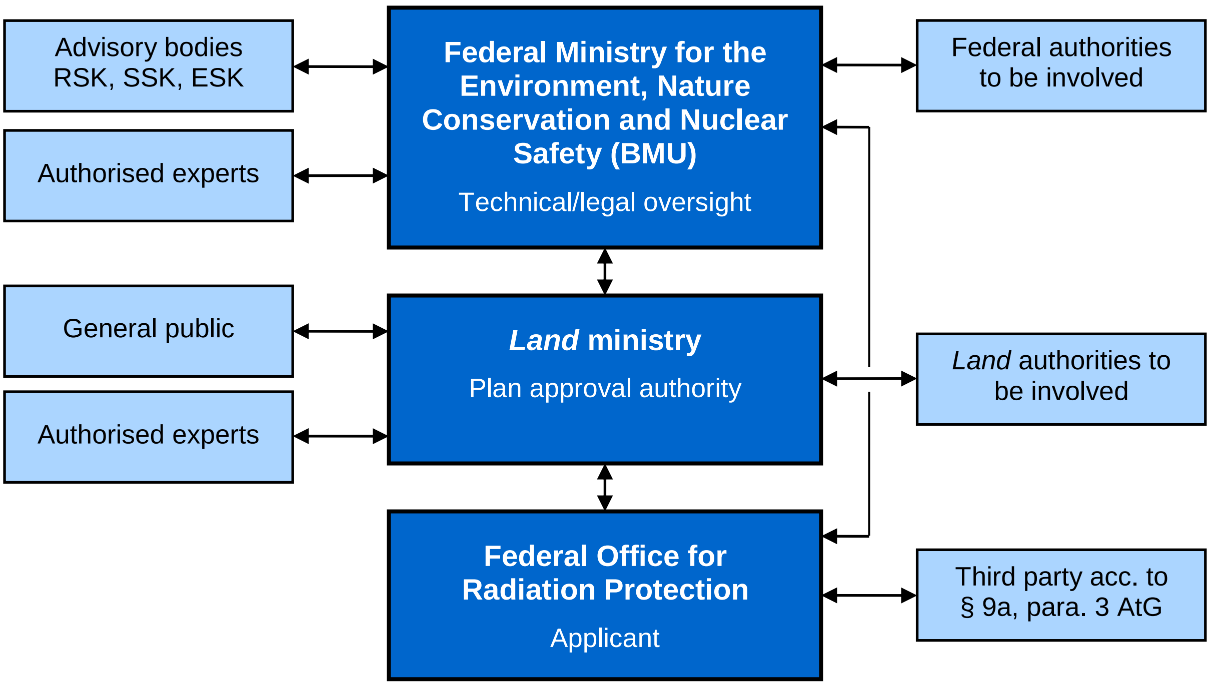
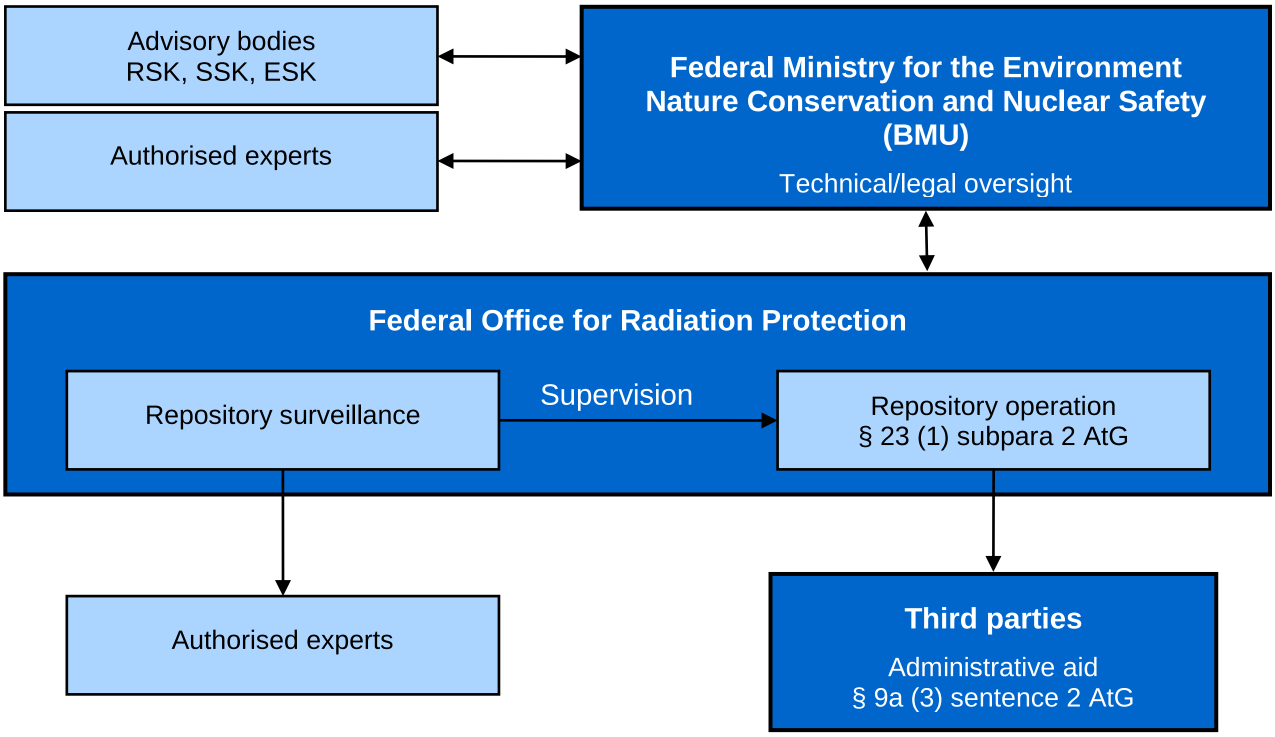


Figure E-4: Parties involved in repository supervision and oversight



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)

Continuous regulatory supervision

Over their operating lives, from the start of construction to the end of decommissioning with the corresponding licences, nuclear installations are subject to continuous regulatory supervision in accordance with § 19AtG [1A-3] and related nuclear ordinances. As with the licencing procedure, a distinction is made between the matters of handling pursuant to §§ 6 and 9 of the Atomic Energy Act, and the installations licenced 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 licenced under §§ 6, 7 or 9 AtG, the *Länder* exercise nuclear supervision. In this respect, they are also acting on behalf of the Federation. In other words, the Federation has the right to issue binding directives on factual and legal issues in each individual case. As in the licencing procedure, the *Länder* are assisted by independent authorised experts. The same applies to the handling of other radioactive substances according to § 7StrlSchV [1A-8].

As in licencing, 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 licencing 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, if 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 (cf. the explanations on § 19, para. 2 AtG).

Contrary to the regulatory supervision by the *Land* for licences according to §§ 6, 7 or 9 regulated according to § 19 AtG [1A-3], supervision of repositories after issuance of the plan approval decision is regulated differently. According to § 9a, para. 3 AtG, the Federation is responsible for the construction and operation of facilities for the safekeeping and disposal of radioactive waste. In § 23, para. 1, subpara. 2 AtG, this responsibility is assigned to the BfS. As part of the executive, the BfS is bound by law and justice according to Article 20 (3) of the Basic Law. It thus has to ensure compliance with the provisions of the Atomic Energy Act and the statutory ordinances issued hereunder and with the terms and conditions of the notice granting the licence, as well as with subsequently imposed obligations. Like regulatory supervision of the holder of a licence pursuant to § 7, this constitutional duty also ensures adherence to law and regulations. For internal supervision of all tasks to be fulfilled regarding radioactive waste repositories, an independent organisational unit – the so-called “Repository Surveillance” – has been established within the Federal Office for Radiation Protection (cf. the remarks on Article 20 (2)of the Convention). The Repository Surveillance is an organisational unit that is independent of the applicant and operator functions according to § 9a and 9b AtG. The comprehensive technical and legal oversight over the BfS is performed by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), to whose portfolio the BfS belongs.

Reporting obligations

The legal basis for the documentation and reporting of radioactive waste is § 70 StrlSchV [1A-8] (Record Keeping and Notification). It requires the record keeping and notification within one month of any extraction, production, acquisition, delivery or other whereabouts if 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 record keeping any time. It may in individual cases grant total or partial exemptions from the requirement to keep records and make notifications.

Much more detailed provisions are included in the BMU 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. The main contents were adopted into the new Radiation Protection Ordinance of 2001. The new Waste Control Guideline published in 2008 [3-60], only contains those aspects that are not covered by the Radiation Protection Ordinance and has been extended to radioactive residues.

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 [1A-3]. 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 AtG). 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 disposal in a repository (§ 9a, para. 1b AtG). 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 AtG). This proof has been furnished if realistic plans for reprocessing, 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 AtG).

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

All safety-related events in installations licenced 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 Atomic Energy Act [1A-3] and the nuclear ordinances contain regulations and the Penal Code [1B-1] contains 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:

- constructs 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.)

For administrative offence, fines may be imposed of 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 supervisory authority is authorised by § 19 AtG [1A-3] 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.

In addition, the supervisory authority may order measures according to § 113 StrlSchV [1A-8] that are necessary to implement the protection provisions.

Enforcement by modification or revocation of the licence

Under certain conditions, stipulated in § 17 AtG, the nuclear supervisory authority may retrospectively decree certain conditions in the licence 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 licencing 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 licencee violates legal regulations or decisions by the authorities.

Experiences

Due to the intensive regulatory supervision (cf. details in 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 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 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.

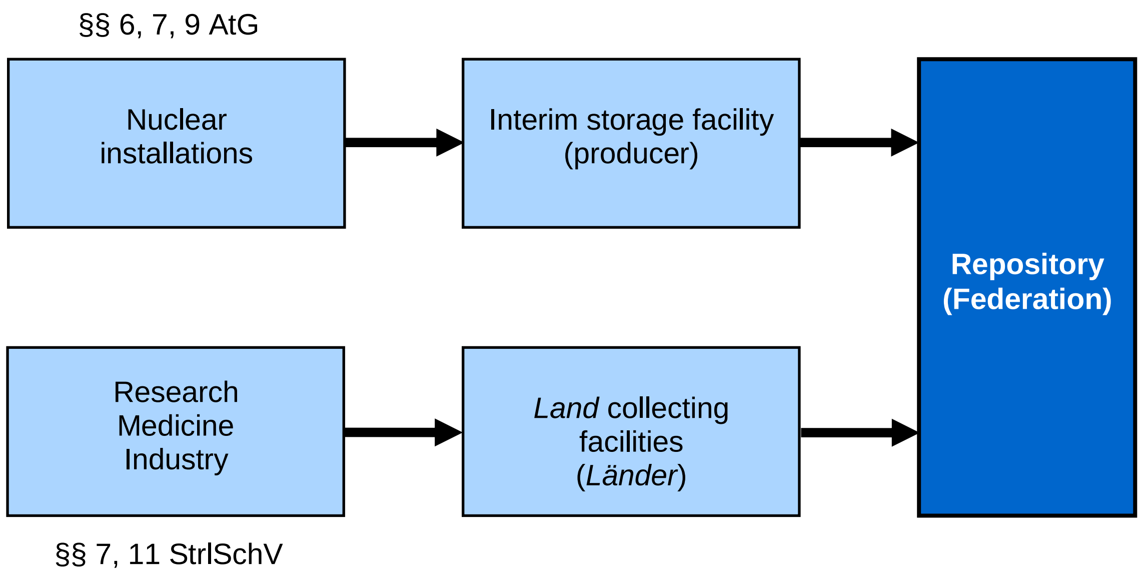
According to § 9a, para. 2 AtG, as a general principle, anyone possessing radioactive waste must deliver it to a repository or to a *Land* collecting facility (cf. Figure E-5).

According to § 9a, para. 3 AtG, the *Länder* are required to establish *Land* collecting facilities for the storage of radioactive waste arising within their territory. Radioactive waste from research, medicine and industry is delivered to these facilities. The producers of radioactive waste arising from the use of nuclear energy are responsible for its interim storage and conditioning.

According to § 9a, para. 3 AtG, the Federation 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 the compliance with the legal requirements and the requirements stipulated in the licence. 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 licenced by the Federation (Federal Office for Radiation Protection).

The polluter-pays principle also applies to the financing of spent fuel and radioactive waste management activities. The Federation refinances the necessary expenses for the planning and construction of repositories at the parties' obliged to deliver material by means of advance payments on contributions. The use of radioactive waste repositories and *Land* collecting facilities is financed or refinanced by costs (fees and expenses) that are payable by the party delivering radioactive waste.

Figure E-5: Obligation for the delivery of radioactive waste and responsibilities (diagram)



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.

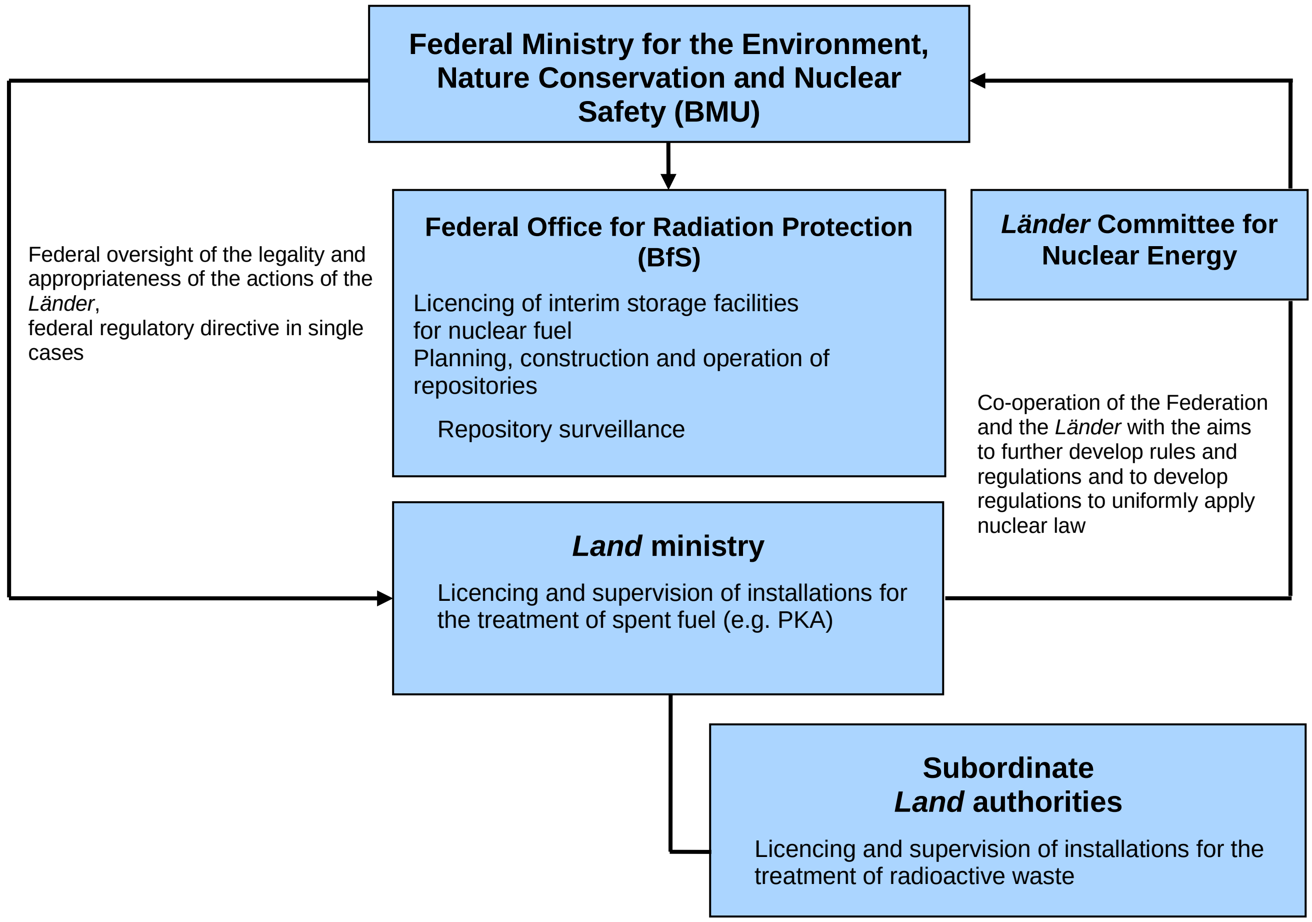
(2) Each Contracting Party, in accordance with its legislative and regulatory framework, shall take the appropriate steps to ensure the effective independence of the regulatory functions from other functions where organisations are involved in both spent fuel or radioactive waste management and in their regulation.

E.3.1. Regulatory body

Competence and authority

In the Federal Republic of Germany as a federal state, the “regulatory body” pursuant to Article 20 consists of authorities of the Federation and the *Länder* (cf. Figure E-6).

Figure E-6: Organisation of the "regulatory body"



By organisational decree, the Federal Government specifies the Federal Ministry competent for nuclear safety and radiation protection. In 1986, this competence was assigned to the then newly founded Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) [1A-3]. Previously, the Federal Ministry of the Interior had been competent for environmental protection as well as for atomic law. The responsibility for the organisation, staffing and financing of the Federal Government's nuclear regulatory authority thus lies with the BMU. The BMU has the organisational powers and applies for the requisite human and financial resources from the annual federal budget.

Regarding the obligations under the Convention, the BMU carries overall state responsibility both towards the interior of Germany and towards the international community that those in charge of the applicants and plant operators, federal and *Länder* authorities, and of the authorised experts' organisations ensure at any time and with a lasting effect the effective protection of man and the environment against the hazards involved in nuclear energy and the harmful effects of ionising radiation.

The fundamental regulations for the further official competences are contained in the Atomic Energy Act (AtG) [1A-3] in §§ 22 – 24 where the regulatory bodies are listed that are responsible for the implementation of and compliance with the provisions of this Act and statutory ordinances issued hereunder:

- According to § 22 AtG, the Federal Office of Economics and Export Control (BAFA) is responsible for licences/approvals involving transboundary transportation of radioactive material 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 [1A-3], the Federal Office for Radiation Protection (BfS) is responsible for the following with regard to the treatment of spent fuel and radioactive waste:
  - the construction and operation of federal facilities for the safekeeping and disposal of radioactive waste and the Asse II mine, the transfer of tasks to third parties by the Federal Government, and the supervision of such third parties,
  - the licencing of nuclear fuel storage outside of federal custody, where this does not constitute preparation or part of an activity subject to licencing 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), sentence 4 AtG).
- According to § 23a AtG, the Federal Office of Administration is responsible for decisions on exceptions regarding preservation orders to secure plans for repository projects or continue a site investigation for facilities intended for disposal of radioactive waste pursuant to § 9g AtG. 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 (of the Atomic Energy Act) 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 licencing 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.

According to § 24 AtG, the respective *Land* government determines the competent supreme *Länder* authorities. Thus, the responsibility for the organisation, staffing and financing of these executive authorities lies solely with the *Land* government. In individual cases, subordinate authorities may also be tasked with supervisory functions.

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 installations 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 and Authorised Experts of the Federation

The nuclear authority of the Federation is a technical department of the BMU – the Directorate-General RS (Safety of Nuclear Installations, Radiological Protection, Nuclear Fuel Cycle). It comprises three directorates. The unit of 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. As at 1 January 2011, Directorate RS III and its four divisions have 28 staff members.

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 four divisions, two of them being responsible for the performance and steering of the projects/facilities. For dealing with generic plant- and site-related issues, a 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 four divisions (interim storage facility and transport licencing procedures, repository projects – exploration and construction, repository projects– decommissioning and waste management issues) and the information centres of the repositories/repository projects have 130 staff members.

For supervision of the compliance with the requirements under nuclear law and the stipulations in the plan approval, the Repository Surveillance unit was set up for the Asse II mine, the Morsleben repository and the Konrad repository, which is under construction. The Repository Surveillance unit currently has 14 staff members. In addition, the BfS has Quality Management Section with a total of 10 staff members being responsible for quality assurance.

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.

Within the Department of Radiation and Environmental Protection, with its departments of nuclear fuel, radiation safety and disposal are around 40 experts engaged with issues of disposal of radioactive waste.

The *Gesellschaft für Anlagen- und Reaktorsicherheit* (GRS) *mbH* is the central scientific and technical expert organisation of the Federation. GRS performs scientific research in the field of nuclear safety and radiation protection, predominantly under federal contracts, including radioactive waste management and disposal, and supports the BMU in technical issues. The Radiation and Environmental Protection Division with its departments Nuclear Fuel, Radiation Protection and Disposal has about 40 experts dealing with radioactive waste management issues.

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

In the 16 *Länder*, there are about 120 staff members working on issues related to radioactive waste management. Another 138 staff members 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 licencing and supervisory authority than those with no or only very small nuclear facilities.

Operation of the Konrad and Morsleben Repositories and the Asse II Mine; Exploration of the Gorleben Salt Dome

For fulfilling its tasks related to the construction and operation of repositories for radioactive waste, 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 administrative aid, in which the public authorities also hold shares. At the DBE, about 610 staff members are working in the field of waste management/disposal in connection with the Morsleben and Konrad repositories and the exploration of the Gorleben salt dome.

For the operation and decommissioning of the Asse II mine, the federally owned Asse GmbH was founded as an administrative aid for the BfS. In this respect, the majority of staff working at the mine was then kept on by the Helmholtz Zentrum München being responsible for the Asse II until then. On 1 January 2009, there were 251 employees at the Asse II mine. As at 30 June 2010 the number of staff was 261 which has been particularly increased in the field of radiation protection since early 2009.

Advisory Commissions and Authorised Experts

The Reactor Safety Commission (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. In addition, it substantially contributes to the advancement of the safety standards in nuclear facilities. At present, the RSK consists of 16 members, who are appointed for a period of three years. The statements and recommendations of the RSK are published on the Internet (www.rskonline.de).

The Commission on Radiological Protection (SSK), founded in 1974, currently has 14 members. It gives recommendations to the BMU on all issues related to the protection of the population as well as employees in medical facilities, research, industry and nuclear installations against ionising and non-ionising radiation. The statements and recommendations of the SSK are published on the Internet (www.ssk.de). Further, in the event of a nuclear or radiological incident or corresponding exercises, the SSK will set up the SSK Crisis Management Group.

In 2008, the Nuclear Waste Management Commission (ESK) was founded due to the increasing importance of issues related to nuclear waste management. It currently has 11 members and performs the tasks until then performed by the RSK committee on waste disposal. With the ESK, an advisory body has been established which, with its way of working, takes into account the increasing importance of nuclear waste management issues and brings together a broad spectrum of technical expertise. International experiences and approaches will be included in the Commission's work, a reason why besides experts from Germany, experts from France and Switzerland are also members of the Commission. The experts advise the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) in all matters of nuclear waste management. This comprises the aspects of conditioning, interim storage and transport of radioactive materials and waste, further the decommissioning and dismantling of nuclear facilities as well as disposal in deep geological formations. As a result of its consultations, the Commission reaches resolutions on scientific and technical recommendations or statements directed to the BMU which will be published on the website of the Commission (www.entsorgungskommission.de).

For in-depth consideration of different focal points, the commissions set up committees and working groups, where additional experts may be involved. The members of the commissions represent a broad spectrum of positions supported and views held the state of science and technology. They are independent and not bound to any directives. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) appoints the members of the Commission for a period of up to three calendar years. In general, reappointments in direct succession are possible but should be limited to total tenures of office of no more than six 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 Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) can dispose of an approximate annual budget of € 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 and ESK), 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 (BMWi) 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 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 BMWi, is charged with geoscientific issues for German repository projects. The BGR is generally financed from the BMWi budget. However, special tasks in the field of 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 - EndlagerVlV*) 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.

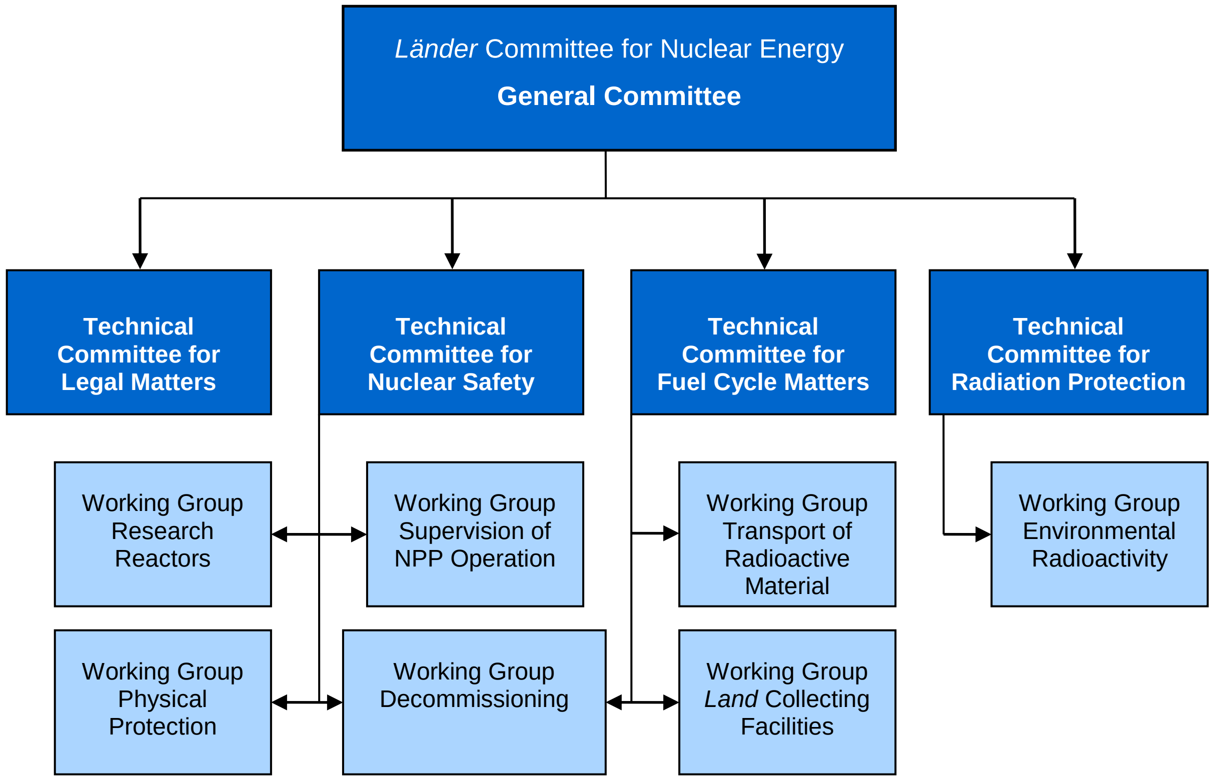
For the decision on licence applications, costs will be charged to the applicant by the competent authorities (Federal and *Land* authorities), which cover the expenses of the authorities and the costs for the consultation of authorised experts (§ 21 Atomic Energy Act).

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 licencing 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 nuclear law as well as for the preparation of amendments and the further development of legal and administrative provisions as well as of the non-mandatory guidance instruments.

In the interest of an execution of nuclear law that is as uniform throughout Germany as possible, the competent nuclear licencing and supervisory authorities of the *Länder* and the BMU draft any regulations on the uniform handling of nuclear law in consensus. These regulations are then promulgated by the BMU. The BMU chairs the LAA and also manages its affairs. The Committee's decisions are usually by mutual consent.

Figure E-7: *Länder* Committee for Nuclear Energy



For preparing decisions to be taken by the General Committee, the *Länder* Committee for Nuclear Energy (cf. Figure E-7) avails itself of several Technical Committees on the issues of “Legal Matters”, “Nuclear Safety”, “Radiation Protection” and “Fuel Cycle Matters” as well as of the Working Groups assigned to these Technical Committees for special permanent tasks. If need be, the Technical Committees may set up ad hoc Working Groups for special and above all urgent individual issues. The Technical Committees and the permanent Working Groups convene at least twice a year and more frequently if necessary. The General Committee convenes at least once a year.

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

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 at all 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 licencing and supervision generally lies within the responsibility of the *Länder*; legality and appropriateness oversight is performed by the BMU. In the area of economic interests of the nuclear energy industry in Germany, reactor safety research and basic research on the disposal of radioactive waste, the Federation will only take actions through the BMWi.

Regulatory organisation in Germany fulfils the requirements of Article 20 (2) of the Joint Convention.

This applies, in particular, to the organisation of the planning, construction and operation of repositories for radioactive waste. According to § 9a, para. 3 AtG, this is a federal task allocated to the Federal Office for Radiation Protection for execution.

The licencing procedure for such a federal repository takes the form of a so-called plan approval procedure (cf. details in 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 licencing authority. Legality and appropriateness oversight regarding the application of nuclear law by the respective *Land* is performed by the federal ministry responsible for nuclear safety (federal oversight). The corresponding *Land* authority decides on plan approval.

The supervision of the compliance with the requirements under nuclear and radiation protection law and the stipulations in the plan approval licences is ensured by a system that works in two ways. At the BfS, internal supervision takes place through the organisational unit “Repository Surveillance”. The Repository Surveillance applies its expertise independently from the BfS units responsible for the construction and operation of the repositories. Any possible BfS-internal conflicts of interest are precluded by organisational measures, such as having its own budget for the appointment of experts. On the other hand, the assertiveness of the Repository Surveillance has been ensured by the fact that specifications issued by the Repository Surveillance can solely be cancelled by the BfS President, who informs the BMU, which then has the opportunity to perform its oversight function.

In addition to the BfS-internal supervision, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) undertakes the comprehensive technical and legal oversight over the BfS. Within this framework, it also supervises the compliance with the provisions under the Atomic Energy Act.

F. Other general safety provisions

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

Developments since the Third Review Meeting:

The "Guide to the decommissioning, the safe enclosure and the dismantling of facilities or parts thereof as defined in § 7 of the Atomic Energy Act" [1A-3] was revised and published in the Federal Law Gazette in 2009 (BAnz. 2009, Nr. 162a). It replaces the "Guide to the decommissioning of facilities as defined in § 7 of the Atomic Energy Act" of 14 June 1996.

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 licencee 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 licencing. In the case of handling of nuclear fuels licenced under § 6 AtG (e.g. interim storage facilities for spent fuel) [1A-3] or facilities licenced under § 7 AtG (e.g. conditioning plants for spent fuel), 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 authorised board members to represent it, the licence holder has to nominate to the competent authority the individual from the circle of authorised board members who assumes the role of radiation protection supervisor. 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 he has to appoint a sufficient number of radiation protection commissioners 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 licenced under § 7 AtG para. 1 or facilities licenced under § 6 AtG, 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 licencee, 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 individuals will personally meet their respective obligations. If this is not the case, the authority can question the trustworthiness of such individuals, which is a prerequisite for granting the 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 waste, 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 [1A-3], the BfS 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 licencee (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 licencees 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 is 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 construction 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 construction and management of the installation and the supervision of its operation; and the persons responsible for the construction 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 Nuclear Safety Officer and Reporting Ordinance (AtSMV) [1A-17] regulates the appointment of nuclear safety officers for nuclear installations licenced under and § 7, para. 1 AtG and § 6 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 nuclear power plants, which are applied accordingly. Furthermore, the exchange of information and knowledge, including experience feedback, is regulated in special requirements.

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.

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) [1A-8] 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 StrlSchV.
- 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 accordingly 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, Stuttgart and Zittau universities. Officially recognised radiation protection courses are held e.g. at the university and non-university institutes that are joined in the Quality Association of Radiation Protection Course Providers (*Qualitätsverbund Strahlenschutzkursstätten* - QSK). 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 to be 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 Karlsruhe Institute of Technology (KIT) with the universities of Karlsruhe, Heidelberg and Stuttgart as well as the Materials Testing Institute University of Stuttgart, the Jülich Research Centre together with the RWTH Aachen and the FH Aachen/Jülich, the Helmholtz Centre Dresden-Rossendorf together with TU Dresden and Zittau/Görlitz University of Applied Sciences, the *Gesellschaft für Anlagen- und Reaktorsicherheit* (GRS) together with TU München, and the Federal Institute for Geosciences and Natural Resources (BGR) of the University of Hanover and TU Berlin (cf. Figure F-1). Apart from the national co-ordination of tasks in the field of nuclear safety and repository research, by analysing the education and training situation and providing forecasts for the future, the Alliance for Competence contributes to the determination of the need for junior experts to maintain the necessary competence and thereby reduce the deficit. The success of the work of the Alliance for Competence in the past 10 years is mainly due to the improved development of the courses on offer, which in Germany has led to 15 new professorships in nuclear technology, while only five professorships had been forecast for 2010 in the year 2002.

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

The intensification of the co-operation with the universities at regional level has led to the formation of four affiliated alliances: the *Kompetenzzentrum Ost für Kernenergie* (Competence Centre East for Nuclear Energy) (2004), the *Südwestddeutsche Forschungs- und Lehrverbund Kerntechnik* (South-West German Nuclear Technology Research and Teaching Alliance) (2007), the *Kompetenzverbund Strahlenforschung* (Alliance for Competence in Radiation Research) (2007), and the *Forum Kerntechnik West* (Nuclear Technology Forum West) (2009).

- The aim of the *Kompetenzverbund Strahlenforschung* (Alliance for Competence in Radiation Research) 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. The maintenance of existing professorships and the establishment of new professorships as well as the establishment and development of working groups are to be promoted. Members of the Alliance for Competence in Radiation Research are seven Helmholtz research centres, i.e. the *Helmholtz Zentrum München* (HZM), the *Gesellschaft für Schwerionenforschung* (GSI), the *Forschungszentrum Jülich* (FZJ), the Karlsruhe Institute of Technology (KIT), the German Cancer Research Centre (DKFZ), the Helmholtz Centre for Environmental research (UFZ) and the Helmholtz Centre Dresden-Rossendorf (HZDR) as well as the Federal Office for Radiation Protection (BfS).
- The aim of the *Forum Kerntechnik West* (Nuclear Technology Forum West), which was founded in Essen, is the cross-linking and bundling of nuclear projects and the nuclear know-how in research, teaching an industry in western Germany.
- 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 opportunities to pursue diplomas and gain practical work experience in industrial companies offer students the chance to orientate their academic training increasingly on the conditions of the world of employment. The sponsorships based partly in general agreements between industrial companies and universities refer 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 was founded at the Clausthal University of Technology. It comprises all disciplines relevant for 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 and offers a master's programme "Radioactive and Hazardous Waste Management", which is unique in Germany. So far, three students have completed this course successfully; five other students are currently enrolled for this course. An introduction to the topic area of waste management is also given to the students who in the 2010/2011 winter term began the new "Nuclear Safety Engineering" master's programme at RWTH Aachen; this includes several modules, such as nuclear fuel cycle and waste management, intended to encourage students to study waste management issues at greater depth. In all 13 students enrolled for the 2010/11 winter term. A steady growth of student numbers is expected for the coming terms.

The training and further qualification of expert staff from authorities and authorised expert organisations is the objective of the events offered by *Gesellschaft für Anlagen- und Reaktorsicherheit* (GRS) *mbH* within the framework of its GRS Academy. This includes in particular the seminars for authority personnel and the Trainee Programme:

- The seminars for authority personnel, which are conducted by GRS at regular intervals, are intended above all for junior authority staff. There are seminars on the following topics: fundamentals of reactor physics, nuclear fuel supply and waste management, prominent events / incidents / accidents in nuclear installations, INES User Manual of the IAEA, fundamentals of radiation protection, radiation emergency preparedness, regulatory supervision of the operation of nuclear reactors, legal and technical nuclear standards, selected topical issues of the nuclear licencing and supervisory procedure, fire protection in nuclear power plants, and operation management of nuclear power plants.
- The Trainee Programme for aspiring authorised experts in the field of nuclear safety lasts one year and is a hands-on introduction to the professional life of an authorised expert. During the programme, the trainees become familiar with the various activities and tasks of an authorised expert both in theory and in practice. The theoretical training is based on a modular training programme. Internationally renowned experts from GRS and other institutions impart sound technical knowledge and give a comprehensive overview of the state of the art in science and technology to the trainees. The focus is on technical knowledge of nuclear safety and the international co-operation in this area. Additional courses deal among other things with the topics reactor physics, physical protection, and reactor systems engineering. During the practical part of the training, the trainees learn about the work in the technical divisions of GRS on the job.

A further institute offering training is the European Nuclear Safety Training and Tutoring Institute (ENSTTI), a joint initiative of the four European expert organisations GRS (Germany), IRSN (France), UJV (Czech Republic) and LEI (Lithuania). ENSTTI wants to attract above all persons from those countries that so far have no technical safety organisation (TSO) of their own and intend to build up such an organisation in the near future. Being the first to do so, ENSTTI offers international training for aspiring experts from the nuclear sector. The first training modules started in Garching in July 2010, with more than 20 young scientists from Europe, Asia, Africa and South America taking part.

To promote and develop scientific and technical collaboration of the technical safety organisations (TSO) in Europe in the field of nuclear safety, the technical safety organisations IRSN, GRS and AVN (now Bel V) founded the "European TSO Network" (ETSON) in May 2006. The objective of the network is to be achieved especially by a systematic exchange of R&D results as well as by exchanging experiences with the operation of nuclear installations and with safety assessments. It furthermore wants to contribute to the harmonisation of European practices of assessing nuclear safety and support initiatives for the development and realisation of European research programmes. All in all, these activities serve an effective advancement of the state of the art in science and technology by employing common resources and synergies in all fields of work.

Already upon the foundation of the network, it was decided to allow all other European TSOs access to this co-operation. In a first step of enlargement, the Finish TSO VTT and the Czech u TSO UJV joined the network in November 2008, followed in 2010 by the Lithuanian TSO LEI, the Slovak TSO VUJE and – as associated member – the Ukrainian TSO SSTC NRS (State Scientific and Technical Centre for Nuclear and Radiation Safety). The ETSON partners committed themselves to working together in striving to achieve the common objectives and campaign for the worldwide networking of TSOs.

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) [1A-3]. 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 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 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 licencee 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 licencing 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 [1A-3] 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 licenced. 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

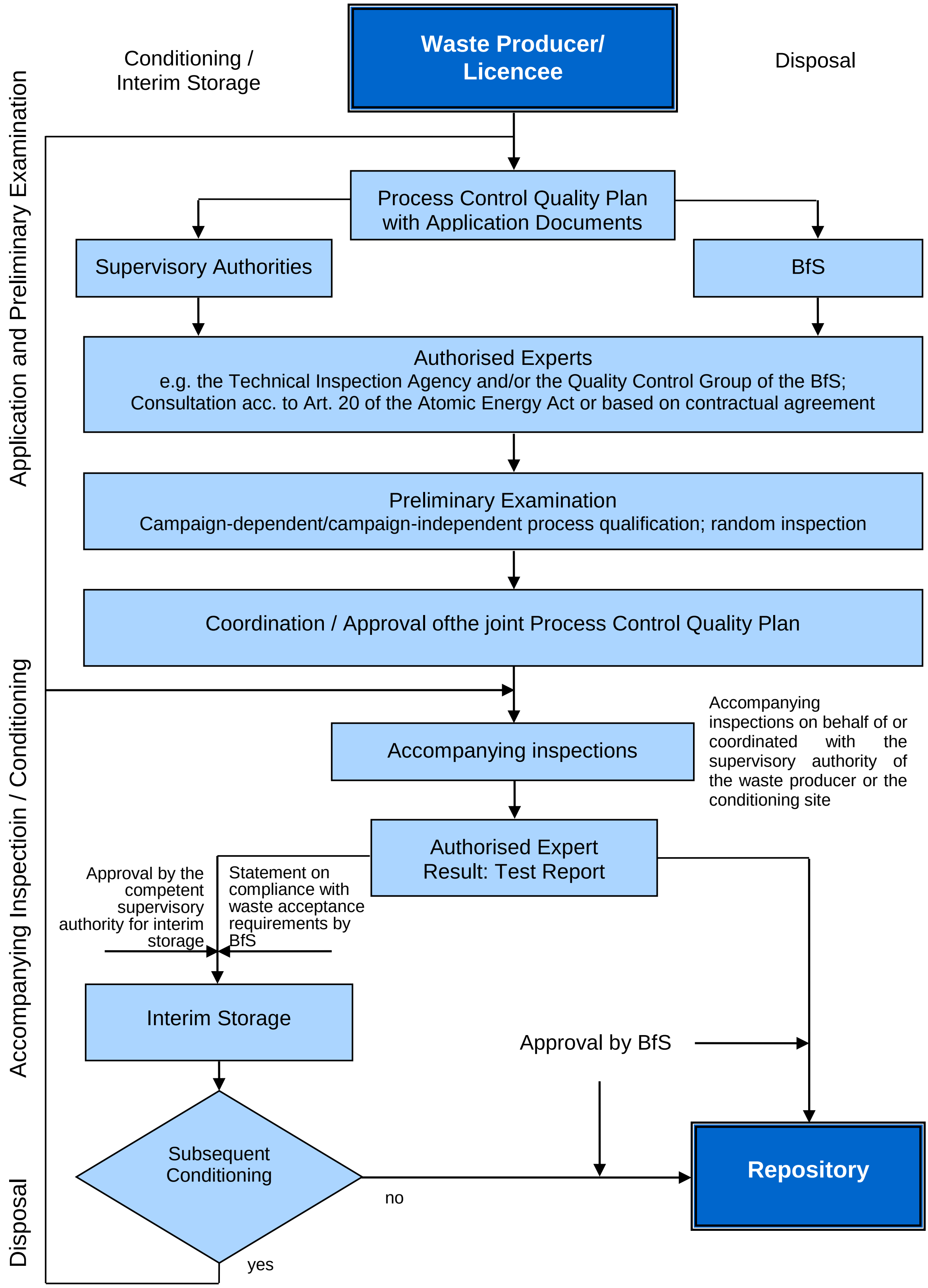


Figure F-3: Wipe test for product control on a MOSAIK container (Copyright: GNS)

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 licencing authority for the Konrad repository within the scope of the licencing 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 disposal. According to the Guideline on the Control of Radioactive Waste Materials and Radioactive Waste [3-60] 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 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 waste shall be subjected to post-qualification. Only the difference to the already verified requirements has to be checked because since 1989 (*Abfallkontrollrichtlinie* – Waste Control Guideline) [3-59], the treatment of radioactive waste destined for disposal has been exclusively performed according to qualified procedures.

Until today, there are no quantitative requirements or limit values for disposal of heat-generating radioactive waste in Germany. For later disposal in a federal repository, the compliance with waste acceptance requirements for 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 waste with negligible heat generation. The objective of procedure qualification is to record the repository-relevant characteristics and data already during conditioning of the waste 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 disposal can be avoided.

Table F-1: Process control quality plan with working and inspection steps

PCQP No.:		Date:	Campaign: Conditioning of … and disposal in a federal repository							Sheet 1 of X
Waste type:										Repository: federal repository
Working step	Inspec-tion step	Description of the working or inspection step	Form sheet/ Instruction	Inspector			Insp.per-formed			Proof
				W	K	T	W	K	T	
A1		Application of a disposal campaign to the BfS	Applica-tion form	X						
A2		Submission of the available documentation to the authorised expert commissioned by the BfS (and the one commissioned by the regulatory authority)		X						
A3		Campaign-dependent procedure qualification by the authorised expert commissioned by the BfS and submission to the BfS (and regulatory authority)				X				
A4		Approval of the process control quality plan by the BfS (and of the campaign by the regulatory authority)								
A5	P1			X	X	X*				
.	.									
.	.	Conditioning and inspection steps								
.	.									
An	Pm			X	X	X*				
An + 1		Preparation of the overall documentation and submission of the waste data sheets and supplementary documents to the authorised expert commissioned by the BfS		X						
	Pm+1	Inspection and attestation of the waste data sheets and preparation of the inspection report by the authorised expert commissioned by the BfS				X				
Preparation or review of the process control quality plan			Approval of the process control quality plan by the BfS	(Approval of the campaign by the regulatory authority)						W = Contracting party
										K = Ordering party
Date:		Approval:	Date:	Signature:	(Date:			Signature:)		T = expert or consulted authorised expert
W										
T										* = pending approval

Regarding the obtaining of the approval of the BfS required in § 74, para. 2 StrlSchV [1-A8] in connection with procedures for the treatment and packaging of radioactive waste with a view to producing waste packages suitable for disposal, the conditioning of radioactive waste with negligible heat generation usually takes place according to the process control quality plans that have been approved by the BfS. For this purpose, all relevant working and inspection steps are specified in a process control quality plan (cf. Table F-1).

The process control quality plan regulates in particular (working steps and inspection steps correspond to the respective steps of Table F-1):

Working step 1:

- Application of the disposal campaign at the BfS and the waste management campaign at the competent regulatory authority

Working step 2:

- Submission of the available documentation to the authorised expert commissioned by the BfS

Working step 3:

- Campaign-dependent procedure qualification by the authorised expert commissioned by the BfS
- Plant-specific procedure qualification by the authorised expert commissioned by the regulatory authority

Working step 4:

- Approval of the process control quality plan by the BfS and of the campaign by the regulatory authority

Working step 5–Working step *n*, Inspection step 1–Inspection step *m*:

- Determination and registration of the characteristics of the raw waste
- Processing of the waste
- Control and characterisation of the products
- Packaging of the waste products
- Control of the waste packages with regard to their compliance with the waste acceptance requirements for disposal
- Possibly necessary transports and interim storage
- Preparation of an inspection report by the authorised expert on site

Working step n+1:

- Preparation of the waste package documentation as well as of the waste data sheets and submission to the authorised expert commissioned by the BfS

Inspection step m+1:

- Inspection and attestation of the waste data sheets and preparation of an inspection report by the authorised expert commissioned by the BfS

Finally:

- Statement by the BfS on the waste package's suitability for disposal

The procedure described in the process control quality plan is assessed separately for individual raw waste campaigns with regard to its suitability for the production of waste packages that are suitable for disposal. Clearance of the procedure by the BfS is subject to the specification of accompanying controls verifying compliance with the waste acceptance requirements for disposal.

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 [IAEO 96] and the recommendations of the ICRP are taken into account. The ALARA principle is taken into account by § 6 StrlSchV which forbids any unnecessary radiation exposures and contamination of man and the environment and which contains an obligation to keep the contamination of man and the environment as low as possible, even below the limits (imperative of minimisation), by taking into account the state of the art in science and technology and consideration of all circumstances of the individual case.

F.4.2. Radiation exposure of occupationally exposed individuals

The Radiation Protection Ordinance distinguishes in § 54 between two categories of occupationally exposed individual, namely between Category A and Category B. This categorisation is made for the purpose of defining the corresponding necessary control and occupational health precaution. For individuals of Category B, the effective dose may exceed 1 mSv during a calendar year, for individuals of Category A it may exceed 6 mSv. Furthermore, different maximum organ doses are defined for the two categories. 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 [1A-8], 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-2.

Exceptions to these limits apply to minors under the age of 18, for whom the effective dose limit is only 1 mSv during a calendar year (instead of 20 mSv/a). In individual cases, the authority may permit effective doses of up to 6 mSv during a calendar year for apprentices and students 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 an unborn child whose mother may continue working as occupationally exposed person after her pregnancy has become known, the limit is 1 mSv for the time from the notification of the pregnancy until its end if an incorporation of radioactive materials can be excluded. The dose limit refers to the sum of external and internal radiation exposure.

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 [1A-3] 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 internal and external 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. 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. For work to be carried out in the restricted-access areas, radiation protection instructions are drawn up as part of the preparation of the work, specifying the actions to be taken.

According to § 6 StrlSchV [1A-8], 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 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, even if it lies below the legal limits. 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 technical qualification 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 [1A-8], it is a general rule for all nuclear installations and 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-2.

Table F-2: 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

§	Scope of application	Period	Limit [mSv]
49	Accident planning reference levels for the operation of nuclear power plants, for the on-site storage of irradiated fuel assemblies, and for Federal facilities for the securing and disposal of radioactive waste		
	Effective dose	From event until the age of 70	50
	Organ dose for thyroid gland and lens of the eye	From event until the age of 70	150
	Organ dose for skin, hands, forearms, feet, and ankles	From event until the age of 70	500
	Organ dose for gonads, womb, red bone marrow	From event until the age of 70	50
	Organ dose for bone surface	From event until the age of 70	300
	Organ dose for large intestine, lung, stomach, bladder, chest, liver, oesophagus, thyroid gland, and other organs or tissue not named above	From event until the age of 70	150
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	From notification of the pregnancy until its end	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)		
	Effective dose	Whole lifetime	100
	Organ dose for the lens of the eye	Whole lifetime	300
	Organ dose for skin, hands, forearms, feet and ankles	Whole lifetime	1 000
59	Averting dangers to people (only volunteers over 18 years of age)	Calendar year Once a lifetime	100 250

If the nuclear installations or facilities concerned are subject to licencing under §§ 6, 7 or 9 of the Atomic Energy Act [1A-3], or authorised by means of the plan approval process under § 9b AtG (such as the Pilot Conditioning Facility for spent fuel (PKA), the Karlsruhe Vitrification Plant (VEK) for fission products, the interim storage facilities for spent fuel and repositories), the radiation exposure is determined at the planning stage for reference persons and the worst-case exposure locations, so as to verify compliance with the limits.

During operation of the nuclear installations and facilities, 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 for spent fuel do not generate any discharges of radioactive waste water, since any contaminated waste water e.g. from maintenance work on the containers 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 installations and facilities not subject to licencing 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 [1A-8], such as conditioning facilities or interim storage facilities for radioactive waste, 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 [1A-8], the following requirements apply to the design of on-site interim storage facilities for spent fuel, and to repositories for radioactive waste:

- a maximum effective dose of 50 mSv due to the release of radioactive substances into the environment (calculated across all exposure paths until the reference person's age of 70) 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 installations and facilities, it is necessary to demonstrate during the licencing procedure that they are designed to avert certain accidents, the so-called design basis accidents, in accordance with these specifications.

For all other nuclear installations and facilities according §§ 6, para. 1, 7, para. 1 and 9, para. 1 AtG [1A-3], § 50 StrlSchV also applies to activities according to § 7 StrlSchV 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 licencing agency according to the hazard potential and the probability of accidents at a given plant. Until general administrative rules on accident prevent enter into force for these installations, an effective dose of 50 mSv has been set for activities according to § 7 StrlSchV in line with § 117, para. 18 StrlSchV for the worst-case accident.

F.4.5. Limitation and minimisation of operational discharges of radioactive substances

Discharges

According to § 47 StrlSchV [1A-8], 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 discharges 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 radiation exposure of reference persons at the most unfavourable exposure location is used as the basis for determining the permissible discharge values at the planning stage of nuclear facilities already. According to § 47, para. 1 StrlSchV, an effective dose of 0.3 mSv per calendar year for discharges in vent air and waste water may not be exceeded, with organ dose limits applying separately. 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].

With respect to minimisation of radiation exposure, reference is made to the remarks on Article 24 (1).

Clearance of material

Overview

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 dealt with because of its particular significance for management of waste and residual materials. However, clearance of solid or liquid materials in accordance with § 29 StrlSchV [1A-8] 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, if necessary – are so low that they may at the 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. The criterion for triviality for each clearance option is defined in § 29, para. 2 StrlSchV [1A-8] as an effective dose of 10 µSv per year for individual members of the general public, in conformity with the regulations according to Council Directive 96/29/EURATOM [1F-18]. 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.

If specific definitions of the Radiation Protection Ordinance on clearance are missing for specific purposes or if no clearance values are specified in the Radiation Protection Ordinance, a so-called "case-by-case decision" (*Einzelfallnachweis*) of compliance with the effective dose of 10 µSv/a for individual members of the general public is to be carried out. In such cases, the dose is determined on the basis of site specific conditions and considerations relating to the site or the intended use, recycling or disposal of the material, respectively.

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

Materials suitable for clearance

Residual materials generated from the controlled and supervised areas of nuclear installations are considered as potentially radioactive and must therefore initially not leave the radiation protection areas. However, if these residual materials show a sufficiently low activity or if decontamination and clearance are technically feasible and economically achievable, they can be prepared for clearance. This concerns in particular

- metals (ferrous and non-ferrous metals) from plant components or parts thereof, piping, reinforcements, etc.,
- rubble from the demolition of buildings,
- insulation materials, cables, etc.

The further use or recycling of cleared objects and materials is common practice. Examples are:

- direct reuse of equipment and components from nuclear power plants in other nuclear power plants of the same type with prior clearance (with respect to a facilitation of their transport);
- direct reuse of tools, lathes, tool chests, bur also shielding blocks, steel girders or similar items in civil engineering projects;
- recycling of metals by smelting for the production of waste containers for radioactive waste, but also for the unrestricted conventional recycling (e.g. steel, aluminium, copper);
- use of rubble in building roads and waste dumps;
- use of other materials (electronic scrap, cables, etc.) in its respective resource cycle.

With the progressing dismantling of a nuclear installation, the clearance of buildings and eventually also of the site will become relevant.

Clearance options and clearance levels

§ 29 StrlSchV [1A-8] names a total of nine clearance options, making a distinction between unrestricted and clearance for a specific purpose:

In the case of unrestricted clearance, the materials, buildings or the site need not be controlled for radiological reasons once they have been cleared. The following five clearance options exist:

- unrestricted clearance of solid substances that may afterwards be reused, recycled or also disposed of,
- unrestricted clearance of liquid substances, mainly oils, that may be reused or disposed of after their clearance, e.g. by burning,
- unrestricted clearance of rubble and excavated soil of more than 1 000 Mg per year that after clearance may be used for any chosen purpose, e.g. for the backfilling of excavations, as road bedding, etc.,
- unrestricted clearance of buildings that afterwards may be reused (or demolished),
- unrestricted clearance of soil areas that may subsequently be used for any purposes, e.g. for the construction of houses and apartment buildings, industrial buildings, etc.

As regards clearance for a specific purpose, this refers to clearance processes in which the first step is specified exactly. Their performance is supervised by the authority, and clearance is only complete once the step in question has been brought to a close or has been irreversibly initiated. For this type of clearance, the following four clearance options exist:

- clearance of solid substances for disposal at a conventional landfill site or in a waste incinerator,
- clearance of liquid substances for disposal in a (conventional) incinerator,
- clearance of buildings for demolition, with any conventional use of the buildings prior to their demolition being forbidden,
- clearance of scrap metal for recycling by smelting in a conventional melting shop, e.g. a foundry, a steel works, etc.

For these clearance options, Appendix III Table 1 StrlSchV contains clearance levels. Table F-3 shows examples of these clearance levels for a selection of radionuclides that are of importance in connection with decommissioning and dismantling of nuclear installations. The respective clearance levels are given as mass-related or surface-area-related (Bq/g and Bq/cm², respectively) values. This depends on the type of measurement to be carried out for demonstrating compliance with these clearance levels.

Table F-3: Examples of clearance levels according to Appendix III Tab. 1 StrlSchV

	Exemption value			Unrestricted clearance of:				Clearance of:			
Radio-nuclide	Activity [Bq]	Specific activity [Bq/g]	Surface contami-nation [Bq/cm²]	Solid substances, liquids with the exception of column 6 [Bq/g]	Rubble, excavations of more than 1000 t/a [Bq/g]	Soil areas [Bq/g]	Buildings for reuse or further use [Bq/cm²]	Solids substances, liquids for disposal with the exception of column 6 [Bq/g]	Buildings for demolition [Bq/cm²]	Scrap metal for recycling [Bq/g]	Half life
1	2	3	4	5	6	7	8	9	10	10a	11
H-3	$1 \cdot 10^{9}$	$1 \cdot 10^{6}$	$1 \cdot 10^{2}$	$1 \cdot 10^{3}$	60	3	$1 \cdot 10^{3}$	$1 \cdot 10^{3}$	$4 \cdot 10^{3}$	$1 \cdot 10^{3}$	12.3 a
C-14	$1 \cdot 10^{7}$	$1 \cdot 10^{4}$	$1 \cdot 10^{2}$	80	10	$4 \cdot 10^{-2}$	$1 \cdot 10^{3}$	$2 \cdot 10^{3}$	$6 \cdot 10^{3}$	80	$5.7 \cdot 10^{3}$ a
Cl-36	$1 \cdot 10^{6}$	$1 \cdot 10^{4}$	$1 \cdot 10^{2}$	8	1		30	8	30	10	$3.0 \cdot 10^{5}$ a
Fe-55	$1 \cdot 10^{6}$	$1 \cdot 10^{4}$	$1 \cdot 10^{2}$	$2 \cdot 10^{2}$	$2 \cdot 10^{2}$	6	$1 \cdot 10^{3}$	$1 \cdot 10^{4}$	$2 \cdot 10^{4}$	$1 \cdot 10^{4}$	2.7 a
Co-60	$1 \cdot 10^{5}$	10	1	0.1	$9 \cdot 10^{-2}$	$3 \cdot 10^{-2}$	0.4	4	3	0.6	5.3 a
Ni-63	$1 \cdot 10^{8}$	$1 \cdot 10^{5}$	$1 \cdot 10^{2}$	$3 \cdot 10^{2}$	$3 \cdot 10^{2}$	3	$1 \cdot 10^{3}$	$3 \cdot 10^{3}$	$4 \cdot 10^{4}$	$1 \cdot 10^{4}$	100.0 a
Sr-90+	$1 \cdot 10^{4}$	$1 \cdot 10^{2}$	1	2	2	$2 \cdot 10^{-3}$	30	2	30	9	28.5 a
Ag-108m+	$1 \cdot 10^{6}$	10	1	0.2	0.1	$7 \cdot 10^{-3}$	0.5	6	4	0.8	127.0 a
Ag-110m+			1	0.1	$8 \cdot 10^{-2}$	$7 \cdot 10^{-2}$	0.5	3	4	0.5	249.9 d
I-129	$1 \cdot 10^{5}$	$1 \cdot 10^{2}$	1	0.4	0.1		8	0.4	8	0.4	$1.6 \cdot 10^{7}$ a
Cs-137+	$1 \cdot 10^{4}$	10	1	0.5	0.4	$6 \cdot 10^{-2}$	2	10	10	0.6	30.2 a
Eu-152	$1 \cdot 10^{6}$	10	1	0.2	0.2	$7 \cdot 10^{-2}$	0.8	8	6	0.5	13.3 a
Eu-154	$1 \cdot 10^{6}$	10	1	0.2	0.2	$6 \cdot 10^{-2}$	0.7	7	6	0.5	8.8 a
U-238+	$1 \cdot 10^{4}$	10	1	0.6	0.4		2	10	10	2	$4.4 \cdot 10^{9}$ a
Pu-238	$1 \cdot 10^{4}$	1	0.1	$4 \cdot 10^{-2}$	$8 \cdot 10^{-2}$	$6 \cdot 10^{-2}$	0.1	1	3	0.3	87.7 a
Pu-241	$1 \cdot 10^{5}$	$1 \cdot 10^{2}$	10	2	2	4	10	$1 \cdot 10^{2}$	90	10	14.4 a
Am-241	$1 \cdot 10^{4}$	1	0.1	$5 \cdot 10^{-2}$	$5 \cdot 10^{-2}$	$6 \cdot 10^{-2}$	0.1	1	3	0.3	432.6 a

Once clearance has been granted and the material has left the scope of supervision under atomic law, the provisions of waste management law apply, namely of the Closed Substance Cycle Waste Management Act (*Kreislaufwirtschafts-/Abfallgesetz*). The clearance regulations are devised such that the requirements of conventional waste management law are already adequately taken into account.

Fundamental prerequisites for clearance

Clearance implies the principle that any radiological consequences conceivable for members of the general public will be as low as to be negligible, which means that the clearance is non-detrimental. As the doses potentially resulting from clearance can in no way be verified by measurements, verification has to be in another way. Correlation of the activity levels in the residual materials and the waste with the potentially resulting doses has been established by comprehensive radiological models. This way, proof is furnished that the following criteria are fulfilled upon clearance:

a) *The clearance-related radiological risks for individuals are so low that there is no need for regulatory concern. This is fulfilled as the potential effective dose received by an individual of the population as a result of clearance lies at the most within a range of 10 µSv per year.*

b) *The collective radiological consequences of clearance are so low that there is no need for regulatory concern. This is fulfilled if the potential collective effective dose during one year of the clearance is no more than approx. 1 man-Sievert.*

c) *Besides, there is no noteworthy probability of scenarios occurring during the clearance that might lead to circumstances in which the above-mentioned criteria are not fulfilled.*

The clearance levels are based on comprehensive studies that were initiated by the BMU and whose results have been discussed and checked by the Commission on Radiation Protection (*Strahlenschutzkommission* - SSK). In Germany, first clearance regulations were issued as early as in 1987 as SSK recommendations on the clearance of ferrous metal scrap. Until 1998, several different SSK recommendations on non-ferrous metals, waste intended for (conventional) disposal, buildings and rubble, and on the unrestricted clearance of all kinds of residual materials. In April 1998, these regulations were summarised in a global SSK recommendation followed. The EU Basic Safety Standards for Radiological Protection adopted in 1996 and to be implemented by all EU Member States led in 2001 to the adoption of a fundamentally revised version of the Radiation Protection Ordinance, which for the first time also included clearance regulations.

The Radiation Protection Ordinance is currently undergoing an amendment. This also affects the area of clearance, especially the regulations regarding clearance with a view to disposal. This required the adaptation to changed conditions in landfill and waste law and in the Sewage Sludge Ordinance as well as to expected large amounts of low-level radioactive waste to be cleared – especially rubble – as a consequence of the dismantling of nuclear reactors

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], the obligation exists for certain kinds of installation or activity to be notified to the supervisory authority under the Atomic Energy Act and, if necessary for the protection of the population against risks to life and health, also 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 [1A-17], 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 [1A-8] 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. This regulation serves for the implementation of the EU Directive 89/618/EURATOM. It is based on the idea that in installations whose radioactive inventory lies below the limits mentioned above, it is possible to exclude any serious consequences of incidents and accidents involving radioactive materials and that therefore any specific internal measures will only become necessary above these limits.

The internal measures include in particular the provision of

- the necessary trained personnel for limiting and eliminating the dangers generated 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. Rules of the Nuclear Safety Standards Commission (KTA) 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 licencing procedure must be addressed here.

Monitoring of emissions and immissions during normal operation and in case of accidents

According to § 48 StrlSchV [1A-8], 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 handling of nuclear materials to be licenced under § 7 of the Radiation Protection Ordinance, such as some of the conditioning facilities and interim storage facilities for radioactive waste in which no repairs are carried out.

Other than nuclear power plants, these facilities release only little or - in individual cases - no radioactive materials.

For nuclear installations and facilities requiring licencing or planning approval under §§ 6, 7, or 9b of the Atomic Energy Act, such as the Pilot Conditioning Facility for spent fuel (PKA), the Karlsruhe Vitrification Plant (VEK) for fission products, the interim storage facilities for spent fuel, 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 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 concerning Emission and Immission Monitoring of Nuclear Installations” (*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] contains supplementary specific regulations applicable to interim storage facilities for spent fuel and repository sites for radioactive waste. It stipulates the following provisions:

Interim storage facilities for spent fuel

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 is ensured.

Asse II mine

Monitoring of discharges from the Asse II mine is performed via measurements in the exhaust air current by means of discontinuous or continuous sampling and measurements. In addition, the exhaust air throughput is continuously measured.

No operational waste water is discharged from the mine. Thus, there are no corresponding discharge values for waste water. As a result of an internal self-imposed restriction, any brine that is collected will only be discharged if the tritium activity is below 40 Bq/l. As the discharge limit is 140 000 Bq/l, no further monitoring is necessary.

Dose-determining substances in the return 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-4 shows the discharges of radioactive materials with the return air for 2010. All nuclides found in higher concentrations as in the ambient air are included.

Table F-4: Release of radioactive materials with return air from the Asse II mine in 2010

	Exhaust air [Bq]
H-3	$3.8 \cdot 10^{10}$
C-14	$9.0 \cdot 10^{8}$
Rn-222	$1.1 \cdot 10^{11}$
Short-lived decay products of Rn-222 at equilibrium	$5.5 \cdot 10^{10}$
Pb-210	$8.4 \cdot 10^{5}$

Morsleben Repository for Radioactive Wastes (ERAM)

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-5). 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-5: Release of radioactive materials with exhaust air and waste water from the Morsleben repository in 2010

	Exhaust air [Bq]	Waste water [Bq]
H-3	$1.2 \cdot 10^{10}$	$5.6 \cdot 10^{4}$
C-14	$6.4 \cdot 10^{8}$	-*
Long-lived aerosols	$8.9 \cdot 10^{5}$	-*
Radon decay products	$8.8 \cdot 10^{9}$	-*
Nuclide mix except H-3	-*	$1.2 \cdot 10^{2}$

* 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 StrVG, together with the corresponding information system. The IMIS general administrative provision (AVV-IMIS) [2-4] regulates the overall complex of environmental monitoring, with two appendices - the routine measuring schedule and the intensive measuring schedule - defining the measuring scopes and measuring methods for normal conditions and for incidents.

The federal authorities responsible mentioned in § 48, para. 4 StrlSchV [1A-8] in connection with Appendix XIV StrlSchV perform comparative measurements and analyses uniformly throughout the country and develop sampling, analysis, and measurement techniques. The German national metrology institute providing scientific and technical services (*Physikalisch-Technische Bundesanstalt* - PTB) provides radioactivity standards for reference measurements.

The IMIS comprises an automatic measurement network consisting of more than 1800 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 Umweltradioaktivität*) at the Federal Office for Radiation Protection in Neuherberg. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) evaluates the data. If an accident or incident with radiological consequences for the German territory should occur, the BMU will initiate the activation of intensive operation of the monitoring system according to the AVV-IMIS and alerts the *Länder*. Furthermore, the BMU recommends actions to be taken to protect the population after consultation with the *Länder*.

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.*

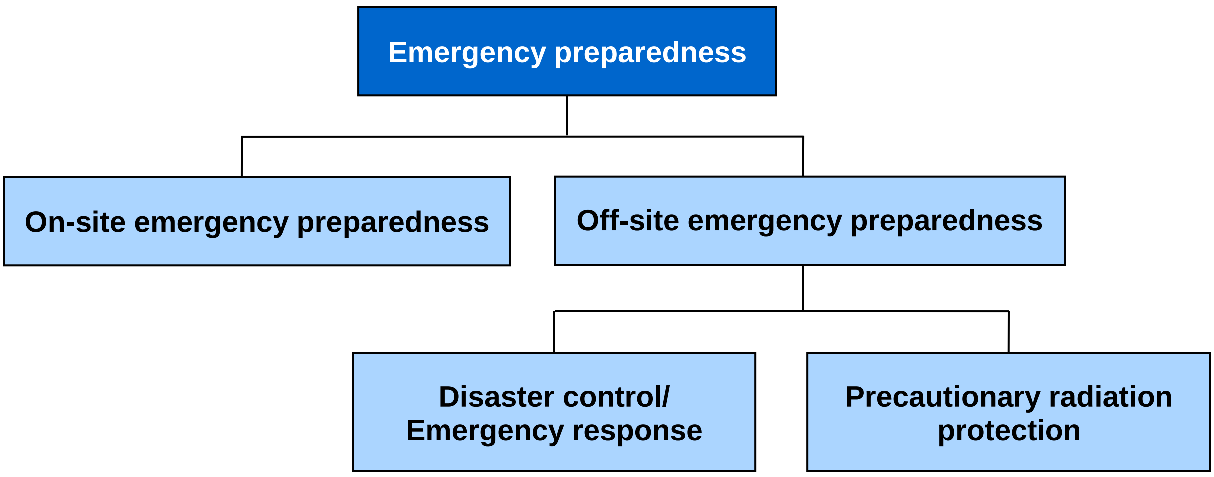
F.5.1. Internal and external emergency plans for nuclear facilities

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 installation or facility; however, the effort required can be reduced for the nuclear facilities under consideration here due to the fact that their hazard potential is substantially lower in some cases compared to that of nuclear power plants.

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 installation or 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 thresholds 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 installations and 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. This usually concerns the handling of radioactive materials subject to licencing 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 installations and facilities.

For the judgement of the need for actions of disaster control/emergency response and precautionary radiation protection in case of accidents in installations in Germany and abroad, there exists 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 08], [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 preventive radiation protection 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 [IAEO 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-6). This is consistent with the approach adopted by the European Commission.

Table F-6: Intervention reference levels for the measures of sheltering, taking iodine tablets, evacuation as well as temporary and long-term resettlement from [3-15]

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	**50 mSv** Children and adolescents up to the age of 18 as well as pregnant women **250 mSv** Individuals from 18 to 45 years		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		**30mSv**	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:

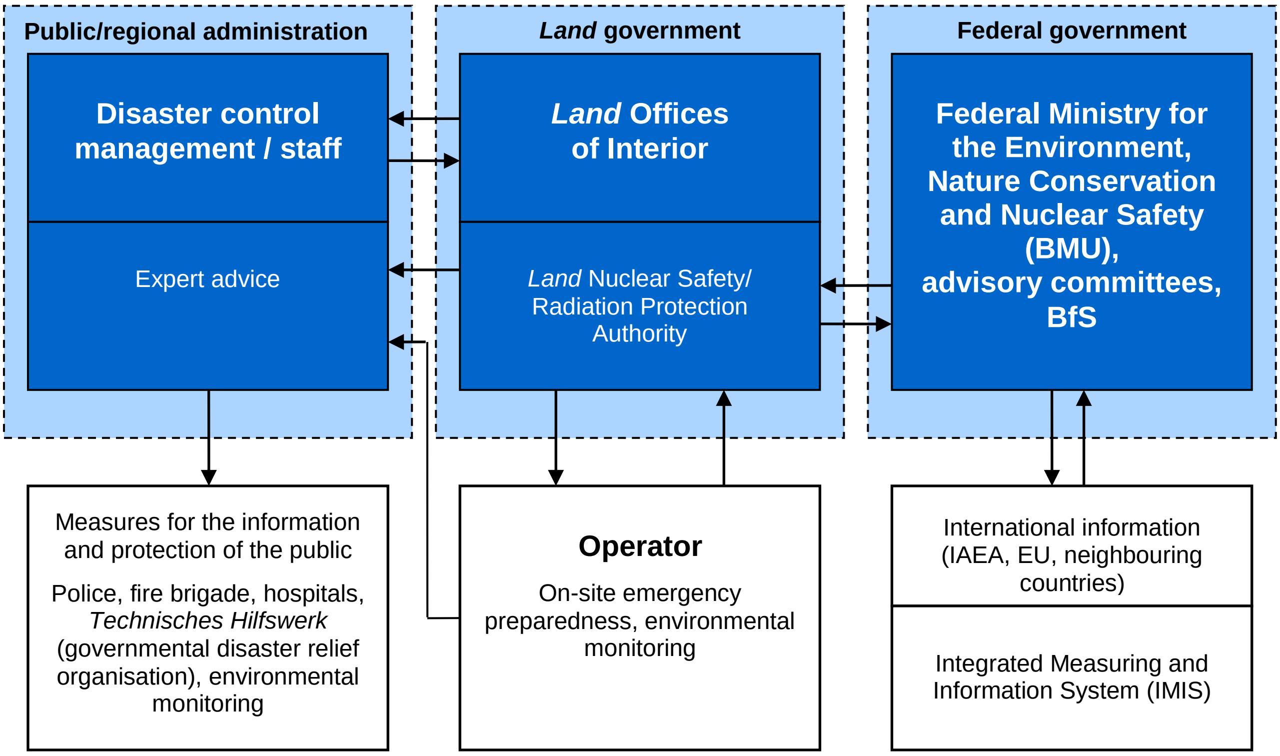
- local dose rate,
- (time-integrated) activity concentrations in the air,
- surface contamination (ground, objects, skin).

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 [1A-8]. The decisions are taken by the competent licencing 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



<u>Responsibilities of the federal government and the *Länder*</u>

In case of need, the BMU makes its resources, including those of the BfS or its advisory committees, 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 and data transmission frequency of the IMIS is increased.

In the event of a radioactive release abroad that has effects on 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 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 installation or facility. The criteria for the nature and scope of emergency planning are determined in particular by the radioactive inventory 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 event 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 applied mutatis mutandis in line with the special requirements of a corresponding 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.

Iodine tablets for blocking the thyroid gland are distributed as a precaution or stored in decentralised stocks. According to [3-15], the following procedure is recommended in this context: to everyone under 45 years of age, iodine tablets are distributed as a precaution to their households within a radius of 0 – 5 km; in the zone between 5 and 10 km, the tablets are distributed as a precaution to households or they are stored readily accessible at several locations in the communes; in the 10 – 25 km zone, the tablets are to be kept in readily accessible storage. The *Länder* regulate this within their own responsibility.

In a radius of 25 – 100 km, iodine tablets are held in stock in several central stores and made available to the *Länder*, if required, for distribution among children and adults under 18 years of age as well as to pregnant women for the purpose of iodine blockage.

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 authorities 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: GNS works fire service during a fire drill at the Gorleben site (Copyright: GNS)

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 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 [1A-8], 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 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.

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 at Ahaus and Gorleben, the interim storage facility "*Zwischenlager Nord*" (ZLN), and the interim storage facility at 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 [1A-8]. 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. However, these facilities are already covered by the extensive emergency preparedness plans of the nuclear power plants.

The Pilot Conditioning Plant (PKA) for spent fuel at Gorleben will not require special measures of off-site emergency preparedness if it becomes operational. The cell wing of the facility is 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 containers. 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. As concerns the Asse II mine repository, emergency measures are planned for the case of a beyond-design brine influx; these, however, only have to be taken in order to limit any possible long-term radiation exposure.

In March 2010, the BfS published an emergency plan for the Asse II mine, comprising the implementation of preventive measures as well as of measures to establish emergency standby and measures to be taken in the event of an impending beyond-design brine influx.

Steps have already been and are being taken to establish emergency standby. These include e.g. the increase of the capacity to discharge inflowing brine to the surface to up to approx. 500 m³ per day as well as the contractual assurance of a disposal option. In this connection, emergency storages for ensuring the replacement of failed equipment and for additional equipment needed in an emergency have been set up and stocked up. (cf. Figure F-7).

Figure F-7: Underground material storage at the 490-m level for an emergency in the Asse II mine (Copyright: BfS)

In the emergency plan, various precautionary measures are identified that according to their dependency and effectiveness are to be implemented step by step by work capacities that are yet to be provided. Part of these precautionary measures is the collection of solution encountered above the emplacement chambers and the backfilling of the cavities lying at floor level and underneath the emplacement chambers or the construction of structures to seal these cavities off in order to delay the release of radionuclides in an emergency.

The Karlsruhe Vitrification Plant (VEK), being an installation for the management of highly active fission product solutions within the grounds of the Karlsruhe reprocessing plant (WAK) has – 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, containers are available which comply with the protection objectives for type-B containers 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 [1A-8] were defined.

The precautions in case of accidents in waste-disposal facilities on neighbouring foreign territory correspond to those applicable to other nuclear installations, 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 08], [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 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 licencing procedures for the decommissioning of nuclear facilities are the Atomic Energy Act (AtG) [1A-3], statutory ordinances promulgated on the basis of the AtG, as well as general administrative provisions. § 7, para. 3 AtG contains the basic requirement for the licencing of decommissioning. It stipulates that for any installation which has been licenced 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 licencing procedure for the decommissioning of nuclear facilities is governed by the Ordinance Relating to the Procedure for the Licencing of Facilities (*Atomrechtliche Verfahrensverordnung*, AtVfV) [1A-10] in accordance with § 7 of the Atomic Energy Act (AtG). 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 construction 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 was given to construction 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 waste.

The implementation of licenced 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 spent fuel, final removal of any residual radionuclides above clearance levels and the release from nuclear regulatory control. Moreover, there are no energy potentials for the dispersion of the radioactive inventory since, contrary to the operational phase; the installation is cold and depressurised. Generally speaking, this coincides with a continuous decrease in the hazard potential as dismantling progresses. This fact is considered, among others, by specific decommissioning regulations and recommendations mainly in the non-mandatory guidance instruments. This is to be taken in to account by application of the existing regulatory framework or by revoking supervisory regulations and requirements during the licencing 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 cover – either partially or in full – the decommissioning of nuclear installations. Generally speaking, the same general safety standards apply during decommissioning of a nuclear facility as during 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 spent fuel has 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).

As a consensus between the Federal Government and the supervisory authorities of the *Länder* concerning a best-possible effective and harmonised approach in licencing procedures for decommissioning, the Main Committee of the *Länder* Committee for Nuclear Energy (LAA) agreed on 26 June 2009 to apply a revised version of the “Guide to the Decommissioning, Safe Enclosure and Dismantling of Installations of Parts of Installations under § 7 of the Atomic Energy Act (AtG)” [3-73] (shortly: Decommissioning Guide) in nuclear licencing and supervisory procedures. This Decommissioning Guide was published on 28 October 2009. It pursues the following aims:

- to compile the aspects of licencing 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 non-mandatory regulatory framework, the planning and preparation of decommissioning measures as wells as licencing and supervision.

It identifies the decommissioning-related provisions in the different documents of the legal and non–mandatory regulations and describes their application. It also contains proposals for an expedient procedure of decommissioning nuclear installations and serves for the harmonisation of the licencing procedures. For example, it is made clear that in connection with the decommissioning and dismantling of nuclear installations, the work has to be organised in projects in accordance with the continuously decreasing hazard potential, and how in this context the regulations can be applied “analogously”, i.e. in the same way as to construction and operation. In all, the Guide thereby promotes the harmonisation of decommissioning procedures, but it does not represent an official guideline or administrative provision.

As a technically oriented supplement to the Decommissioning Guide, the Nuclear Waste Management Commission (*Entsorgungskommission* - ESK) adopted the Guidelines for the Decommissioning of Nuclear Facilities [4-4] on 9 September 2010. The Guidelines were published on 9 December 2010. In these Guidelines, the ESK summarises those technical requirements which it considers necessary for the operators of nuclear facilities to fulfil in order to ensure safety in connection with decommissioning. These requirements relate above all to the preparation and execution of decommissioning; some requirements, however, are also directed at the construction and operation of a nuclear facility as they are highly relevant for the later decommissioning. The Guidelines for the Decommissioning are not legally binding for any third parties. They rather more form the basis for the ESK's assessments when discussing concrete decommissioning procedures. Hence the Guidelines contribute to the state of the art in science and technology of the German nuclear non-mandatory guidance instruments and thereby to a high level of safety of the decommissioning of nuclear facilities.

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 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.

The manner in which the availability of financial resources is secured for the decommissioning phase of a nuclear installation 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 (cf. Table F-7), the Federal Government covers the bulk of the costs. Financing includes all expenses incurred for the post-operational and transition phase, disposal of the spent fuel, execution of the licencing procedure, dismantling of the radioactive part of the facility, and disposal of the radioactive waste, 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. By the expensed formation of reserves during the operational phase of the nuclear power plant, the funds are accumulated, thus preventing the contributions from being distributed as profits to the shareholders. Further reserves are formed for the disposal of the spent fuel.

  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 spent fuel and operational waste), the costs for the licencing procedure and supervision, the costs of dismantling (dismantling and interim storage of all contaminated and activated components and all buildings of the controlled area), and the cost of the interim and final storage of all radioactive waste from decommissioning. The total amount of costs is estimated from cost studies which are updated regularly - with due regard for technical advancements and general price trends - by an independent expert. The reserves are regularly checked by independent financial auditors of the fiscal authorities with regard to their appropriateness.

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

Table F-7: Research facilities in which nuclear installations are operated or decommissioned and which are financed from public funds

Research facility	Short description	Funding
Karlsruhe Institute of Technology (KIT), formerly Karlsruhe Research Centre (FZK)	Founded in 1956 as “*Kernforschungszentrum Karlsruhe*”; initial research topics: development of heavy and light water reactors. Currently various research topics outside nuclear technology. Within the former division of “Decommissioning”, execution of the decommissioning of the research and prototype reactors: FR-2, MZFR, KNK II, operation of conditioning plants and interim storage facilities at HDB. In June 2009, all old nuclear installations were transferred to the “*Wiederaufarbeitungsanlage Karlsruhe Rückbau- und Entsorgungs-GmbH*”, a decommissioning and waste management company of the Karlsruhe reprocessing plant, among them not only the decommissioned FR-2, MZFR and KNK II reactors but also the HDB. Whenever other nuclear research facilities are taken out of operation, these will be transferred to WAK GmbH for dismantling.	Federal Republic of Germany, *Land* Baden-Württemberg
Wiederaufarbeitungs-anlage Karlsruhe Rückbau- und Entsorgungs-GmbH (WAK GmbH)	The Karlsruhe Reprocessing Plant was built between 1967 and 1971, with the Karlsruhe Research Centre being the building contractor. *Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen mbH* (GWK), a company founded by the chemical industry in 1964 to handle the reprocessing of nuclear fuels, was tasked with the operation of the plant. In 1979, GWK was taken over by *Deutsche Gesellschaft für Wiederaufarbeitung von Kernbrennstoffen mbH* (DWK), a subsidiary company of the German electric power industry. Under the name of *Wiederaufarbeitungsanlage Karlsruhe Betriebsgesellschaft mbH* (WAK BGmbH), GWK subsequently carried out the reprocessing operations until the plant's decommissioning in 1990; afterwards, it was in charge of the residual operations and the dismantling of the plant. In 2006, WAK BGmbH was taken over by the state-owned EWN GmbH and has since then been operating under the name of *Wiederaufarbeitungsanlage Karlsruhe Rückbau- und Entsorgungs-GmbH* (WAK GmbH). At the same time, the scope of activities was extended to the operation and dismantling of the vitrification plant. In mid-2009, the old nuclear installations FR-2, KNK II and MZFR as well as the conditioning facilities for radioactive waste	Federal Republic of Germany, *Land* Baden-Württemberg, power utilities

Research facility	Short description	Funding
	of HDB were separated from the Karlsruhe Research Centre and transferred to WAK GmbH. Since then, the latter has been continuing the decommissioning of the research facilities and the operation of HDB. Whenever other nuclear research facilities are taken out of operation by KIT, their dismantling will be handled by WAK GmbH.	
Research Centre Jülich (FZJ)	Founded in 1956 as "*Kernforschungsanlage Jülich*"; initial research topics: development of high temperature reactors. Current research in numerous fields outside nuclear technology. Decommissioning of the research reactors FRJ-1 (fully removed) and FRJ-2. (Close to the FZJ premises, there is the 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, *Land* North Rhine-Westphalia
Helmholtz-Zentrum Geesthacht Centre for Material and Coastal Research GmbH formerly Research Centre Geesthacht (GKSS)	Founded in 1956 as "*Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt*" (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. Decommissioning of the research reactors FRG-1 and FRG-2, execution of the storage and disposal of radioactive waste from the nuclear ship Otto Hahn.	Federal Republic of Germany, *Länder* Schleswig-Holstein, Lower Saxony, Hamburg, Bremen
Helmholtz Zentrum München, Neuherberg	Founded in 1964 as "*Gesellschaft für Strahlenforschung*" (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 Centre for Environmental Health.	Federal Republic of Germany, Free State of Bavaria
Helmholtz-Zentrum Berlin	Founded as the Hahn-Meitner-Institute Berlin in 1959; current research topics in the areas structural research, material sciences etc.; operation of the research reactor BER II	Federal Republic of Germany, *Land* Berlin
Verein für Kern-verfahrenstechnik und Analytik Rossendorf e. V. (VKTA), Dresden	Founded in 1992. VKTA carries out the decommissioning of the nuclear installations of the former Central Institute of Nuclear Research of the former GDR. These are the RFR research reactor and the AMOR facilities for fission molybdenum production. The zero-power reactors RRR and RAKE have already been dismantled and fully removed.	Free State of Saxony
Technische Universität München	Operation of FRM II, decommissioning of FRM	Federal Republic of Germany, Free State of Bavaria
Various universities	Operation / decommissioning of smaller research reactors	Federal Republic of Germany, respective *Länder*

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. In this field, considerable progress has been made in the last years which are summarised in Section F.2.1.

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) [1A-8] 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. Rules of the Nuclear Safety Standards Commission (KTA) in the Appendix). The need for all relevant documentations to be kept available is derived from criterion 2.1 of the "Safety Criteria for Nuclear Power Plants" [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 licencing 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. licencing prerequisites in accordance with § 7, para. 2 of the Atomic Energy Act (AtG) [1A-3],*
>
> *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 licencee 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 incidents and abnormal events as well as the chosen countermeasures,
- record keeping of measurements of individual doses and body doses,
- record keeping on 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 production, acquisition, transfer and other dispositions of radioactive substances and on cleared materials, which is regulated in § 70 StrlSchV [1A-8] 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.

G. Safety of spent fuel management

This section deals with the obligations according to Articles 4 to 10 of the Convention.

Developments since the third Review Meeting:

In spring 2010 WENRA published a revised "Waste and Spent Fuel Storage Safety Reference Levels Report" (version 2.0). The resulting national action plan is in the process of being implemented. In 2010, the ESK adopted recommendations for guidelines for the performance of periodic safety reviews for interim storage facilities for spent fuel and heat-generating radioactive waste in casks. In 2011 and 2012, an updating of the Safety Guidelines for waste storage facilities [4-3] and for the dry storage of Irradiated Fuel Assemblies in Storage Casks [4-2] will be performed by the ESK.

G.1. Article 4: General safety requirements

Article 4: General safety requirements

Each Contracting Party shall take appropriate steps to ensure that 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 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, subcriticality, 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 licencing. The licencing 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 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, KTA 3602 is applied (see enclosed list of Rules of the Nuclear Safety Standards Commission (KTA)), whilst KTA 3303 is applied with regard to the removal of residual heat. Since 2007, the DIN standard DIN 25712:2007-07 (D) “Criticality safety taking into account the burn-up of fuel for transport and storage of irradiated light water reactor fuel assemblies in casks” [DIN 25712] is available.

At present, the nuclear regulations do not yet contain any formulated requirements concerning subcriticality and discharge of decay heat activity in a repository.

According to the safety criteria for the emplacement of radioactive waste 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 waste 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. For this purpose the BMU has submitted “Safety Requirements Governing the Final Disposal of Heat-Generating Waste” which was adopted on 30 September 2010 by the *Länder* Committee for Nuclear Energy (LAA).

G.1.3. Limitation of 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. Due to optimised strategies for nuclear fuel appliance the accumulation of spent fuel management has reduced.

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 (EndlagerVlV) [1A-13] according to which the advance payments for financing a repository are calculated on the basis of the volumes of generated waste.

G.1.4. Taking into account interdependencies between the different steps in spent fuel management

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 (*Entsorgungsvorsorgenachweis*). For this purpose, realistic plans are submitted annually showing that sufficient interim storage capacity remains available for those spent fuel 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 waste from the reprocessing of spent fuel in foreign countries, as well as for the re-use of the separated plutonium from the reprocessing of spent fuel in nuclear power plants, and for the whereabouts of the separated uranium from the reprocessing of spent fuel.

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 ([IAEO 10] and [IAEO 02]), the ICRP and the EURATOM Basic Safety Standards [1F-18] are also referred to. This is ensured by the nuclear licencing applicable to the corresponding nuclear installation (cf. the remarks on Article 19).

Compliance with the provisions of nuclear licencing 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. 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 Licencing Procedure Ordinance stipulates the performance of an environmental impact assessment and compliance with other licencing requirements (e.g. for nonradioactive 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 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 waste in amine 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 [IAEO 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 safety criteria for the emplacement of radioactive waste in a mine [3-13] as well as the “Safety Requirements Governing the Final Disposal of Heat-Generating Waste” [BMU 10] already make allowance for Principle 7 of the IAEA Safety Fundamentals [IAEO 06]. They ensure that no undue burdens are imposed on future generations.

Financial resources have been set aside by the operators of the nuclear power plants, for decommissioning and dismantling, as well as for the disposal of all radioactive waste and spent fuel, and for the disposal of spent fuel on the basis of commercial law. If required, the reserves will also cover the interim storage of spent fuel and radioactive waste in Germany until their disposal. Once a repository has been sealed, monitoring and maintenance measures, apart from minimal evidence and control measures, are not necessary. For this reason, no relevant costs are incurred after sealing that would have to be borne by future generations.

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-mandatory 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 faculties 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.2.2. Periodic Safety Review of interim storage facilities

The overall aim of the Periodic Safety Review (PSR) of interim storage facilities is to review the safety levels of nuclear installations regularly according to the state of the art in science and technology, to assess the determined deficiencies and to remedy the identified deficiencies.

According to § 19a, para. 3 AtG [1A-3] anyone who operates an installation (according to § 2, para. 3a Abs. 1 AtG) is required to conduct and to evaluate every ten years a safety review of the installation and to improve on this basis the nuclear safety of the installation continuously. The results of the safety review and evaluation shall be submitted to the supervisory authority.

Some general requirements in the sense of a Periodic Safety Review, such as the preparation of a report of the status of the storage building and of the components necessary for the interim storage, containing the evaluation of the operating experience or the measures of the ageing management, are already included in the “Safety Guidelines for Dry Interim Storage of Irradiated Fuel Assemblies in Storage Casks” of the RSK (2001 [4-2]).

Detailed requirements for the conduction of a periodic safety review were conducted by the ESK on behalf of the BMU and were adopted as “ESK Recommendations for the conduction of a periodic safety review for interim storage facility for spent fuel and heat-generating waste (PSÜ-ZL)” [4-5] in November 2010 (see also Chapter E.2.2). It is planned to apply the draft of the guidelines for certain interim storage facilities in a two-year testing phase. After a final amendment all the experiences gathered during this testing phase are to become part of the guidelines [4-2].

The PSR is to be conducted ten years after the commissioning, this means after the first emplacement operations, and then every ten years. The key objectives of the PSR are:

1. A summarised documentation and evaluation of all events and insights with regard to the safety level and operating reliability as well as the minimisation of the radiation exposure gathered in the review period,
2. An updated safety assessment in accordance with the state of the art in science and technology, the compliance with the safety requirements with regard to the handling and the later transfer of the transport and storage casks,
3. If necessary, derivation of findings and measures for further operation.

General requirements on content and scope of the PSR are among others:

- An overview of all safety relevant amendments carried out or occurred in the review period,
- Evaluation of operational experience and experiences from the operation of similar plants,
- Review and if necessary update of the accident analysis in regard to design basis accidents and beyond design basis accidents as well as the planned measures,
- Review of the ageing measures (ageing management), and
- Review of the safety management for demonstrating the availability of suitable organisational and personnel measures and their combination with the technical safety precautions.

The result of the PSR should demonstrate compliance with the general radiological protection goal (see Chapter G.5.1) as well as the requirements derived regarding the remaining licenced operating lifetime.

The operator of the interim storage facility is responsible for the conduction of the PSR. The results and the measures derived are to record and to submit to the supervisory authority. If required the supervisory authority defines necessary measures for the operation of the reviewed interim storage facility and supervises the properly realisation at due date. The nuclear licencing authority (Federal Office for Radiation Protection) takes notice of the results of the PSR of the interim storage facility as well as of the assessment by the supervisory authority and if necessary can derive updated or additional requirements for on-going or future licencing procedures.

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 time of operation;

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 faculties 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 licencing of stationary installations for the management of spent fuel, whilst the licencing of the storage of nuclear fuel outside Government custody is regulated in § 6, para. 1 AtG. The definition in the AtG encompasses storage of spent fuel. 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 licencing procedure. The nature and scope of documentation and the data it contains are regulated in the Nuclear Licencing Procedure 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 licencing 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, 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 Licencing Procedure Ordinance (AtVfV) [1A-10] (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 Licencing Procedure Ordinance (AtVfV) [1A-10]. 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 [1A-10], 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 (UVPG), 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 trans-boundary 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 (AtG) [1A-3], 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) allowing a reasonable period of time for a notice on whether participation in the procedure is requested.

The licencing 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 licencing 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 licencing 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 trans-boundary involvement, in particular concerning trans-boundary 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 trans-boundary environmental impacts of the project and any measures for avoiding or ameliorating them.

Furthermore, § 8 of the Environmental Impact Assessment Act (UVPG) 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 licenced 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, 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 [1A-10] (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:*
>
> *i) 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;*
>
> *ii) at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a spent fuel management facility are taken into account;*
>
> *iii) 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 licencing conditions which - if adhered to - ensure that the protection objectives are fulfilled. Both cover the stipulations of the Joint Convention.

During the licencing procedure, the competent licencing 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 management facilities is licenced 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 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 [1A-8] 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 experiences 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. Assessment of safety in the licencing procedure

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 time of operation 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 licencing procedure

The assessment of the safety of nuclear facilities for the treatment of spent fuel (storage facilities and the Gorleben pilot conditioning plant PKA), and the assessment of environmental impacts conducted prior to the construction of such a facility, take place within the context of a licencing 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 licencing 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 licencing 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 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 Licencing Procedure Ordinance (AtVfV) [1A-10], or in the case of facilities for the storage of spent fuel, 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 licencing procedure for the construction of nuclear facilities for the storage of spent fuel 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 licencing and supervision procedure, the competent authorities are responsible for the review of the documents submitted and the licencing prerequisites. According to § 20 AtG [1A-3], 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 licencing 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 programmes 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, 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 may be derived from international recommendations, such as those of the IAEA ([IAEO 10] and [IAEO 94a]).

A licencing 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: 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 licence applications in 1999 and 2000 to build and operate on-site interim fuel assembly storage facilities.

With the exception of one facility that was licenced 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 spent fuel 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 decay heat
  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. Rules of the Nuclear Safety Standards Commission (KTA) in the Annex),
- Safety-oriented organisation and performance of operation,
- Safe shipment off-site of the radioactive materials (see also [IAEO 05]),
- 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 constructed is regulated by [2-1] and [3-33].

In the context of the incident analysis, a distinction is made between external and internal events, the latter being caused by the spent fuel 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 licencing procedure by the competent licencing 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 licences 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 licencing 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 [1A-3]).

G.5.2. Safety assessment in the supervisory procedure prior to 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 licencing documents, modifications become necessary according to § 7, para. 1 or 6 AtG [1A-3] 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 licenced 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 licencing 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: Transport cask storage building at Ahaus (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 programme),
- 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. Rules of the Nuclear Safety Standards Commission (KTA) 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. Rules of the Nuclear Safety Standards Commission (KTA) 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 time of operation 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 time of operation 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 at 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 have a licence for an operating life of 40 years from the beginning of the emplacement. 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 licenced 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 licencing authority upon application of the licencee.

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 are provided and organisational stipulations are specified.
- 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) [1A-8] 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.

Also the reporting obligation of the condition of the storage building and of the components necessary for the interim storage every 10 years is subject of the monitoring concept.

Regulatory supervision ensures compliance with the procedures on operation, maintenance, monitoring, inspection and testing established in the nuclear licencing 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 licenced 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]. The reporting criteria are formulated as far as possible plant-specifically in the Nuclear Safety Officer and Reporting Ordinance (AtSMV). 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 licenced 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). The reporting criteria apply mutatis mutandis to facilities licenced 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) [1A-17]. 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.

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 reused or disposed of. Proof to this effect is checked during the course of the nuclear licencing procedure. Applications for changes to the licenced condition of the facility must either be submitted to the supervising authority for approval or in case of significant modifications to the licencing 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.*

In Germany, all spent fuel from nuclear power plants is intended for disposal, with the exception of those delivered to a reprocessing plant up until 30 June 2005. Since 1 July 2005, the delivery of spent fuel from power reactors for reprocessing is prohibited.

Under the direct disposal concept, spent fuel is 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 in casks that are suitable for disposal has been constructed.

Since no repository has yet been implemented which is capable of accommodating spent fuel, there are only conceptual considerations available on the design of such a repository (cf. the remarks on Articles 13, 16 ix and 17).

The DIN Standards Committee for Materials Testing has published a draft of a new DIN standard 25472 “Nuclear Criticality safety in the context of disposal of spent fuel” for public discussion and commenting. Irrespective of the site and the host rock the DIN standard 25472 regulates the criticality safety of the interim storage during the operational and post-operational phases.

On 30 September 2010 the LAA has adopted the "Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste" [BMU 10] and the BMU has published these for concretisation of the state of the art in science and technology. These requirements are based on a discussion process in which the BMU, GRS and the advisory committees RSK, SSK and ESK, the Federal Office for Radiation protection (BfS) and interested citizens (workshop in 2009) were involved. The Safety Requirements shall replace the "Safety Criteria for the Final Disposal of Wastes in a Mine" [3-13]. The Safety requirements shall apply to the planning, further exploration, construction, emplacement operations and decommissioning of such a final repository, and shall also address the required monitoring and evidence preservation measures following its decommissioning. The aim of these Safety Requirements is to outline the purpose, basic principles and requirements to protect man and environment, and shall be used as a reference for preliminary assessments within the framework of the safety analysis of Gorleben.

In particular, the Safety Requirements regulate the following points:

The step-wise proceeding and optimisation

The timeline from construction to decommissioning of the disposal facility will span a few decades. Any new knowledge acquired and further developments of the state of the art in science and technology have to be taken into account. The concept or the design of the disposal facility shall regularly be reviewed and optimised. This requires a continuously safety management, which is adaptive and which is also continuously optimised. The measures and the derived results shall be documented.

Isolating rock zone

This rock zone lies deep inside of a host rock and is relevant for precautions to prevent damage of radioactive waste. The radioactive waste must be isolated in this rock zone in such a way that it remains in situ and, at best, only minimal quantities of substances are able to exit this rock zone. Additional radiation exposure should only be able to occur in a limited area so that as small a number of people in a generation as possible can be affected.

One million years

The site-specific safety analysis covering a period of one million years is required for the plan approval procedure of the disposal facility. The integrity, i.e. the specified properties of the isolating rock zone, has to be maintained for a million years. This assessment of safety shall comprise all information verifying the long-term safety and shall justify the reasons why this assessment is to be trusted, and also shall demonstrate the level of uncertainty regarding the calculation models.

Retrieval and recovery

During the emplacement operation phase up to the sealing of the shafts or ramps, retrieval of the waste containers must be possible. Furthermore it must be guaranteed that the waste containers can be retrieved for a period of 500 years after the closure of the repository in case of emergency. These requirements, however, must not impair the long-term safety of the repository.

H. Safety of radioactive waste management

This section deals with the obligations according to Articles 11 to 16 of the Convention.

Developments since the Third Review Meeting:

The 60 m³ of liquid high active waste from the operation of the Karlsruhe reprocessing plant have been vitrified, loaded into transport and storage casks and transferred into the interim storage facility "*Zwischenlager Nord"* (ZLN).

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 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.

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 disposal for the Konrad repository Konrad [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 generation 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 licencing 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 licencing 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 [IAEO 00] or [IAEO 95], are also observed.

The protection goals 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 goals also satisfies the requirements of the Convention. This is ensured by nuclear licencing and the corresponding supervision.

In the following, 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, in the interim storage facility "*Zwischenlager Nord*" (ZLN), as well as in the interim storage facility at Gorleben (TBL-G), heat-generating waste is stored. For the interim storage facility at Ahaus, the storage of compacted waste from reprocessing has been applied for.

The HAWC solutions generated during the operation of the Karlsruhe Reprocessing Plant (WAK) have been stored until commissioning of the Karlsruhe Vitrification Plant (VEK). In September 2009, the VEK started hot operation. Until 26 November 2010, the 60 m³ of HAWC solutions and the solutions generated during flushing of the facility have been completely vitrified, thus producing 140 canisters. In five transport and storage casks of type CASTOR HAW 20/28 CG, the canisters were then transferred to the ZLN.

Once vitrification is complete, the former storage facilities and the VEK will be dismantled. This constitutes part of the decommissioning procedure of the reprocessing plant.

Within the context of the licencing procedure, the extent of testing the safety-relevant components and systems as well as the participation of independent experts were defined.

During construction, the supervisory authority performed checks within the framework of quality assurance, among other things, 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, the VEK was subject to an intensive control by the experts of the BfS, on the one hand, and by the supervisory authority and its authorised experts, on the other hand, safety-relevant components and systems were, for example, subjected to in-service inspections. During these tests, the inspectors verified whether these systems and components still met the specified requirements. In addition, wearing parts (e.g. seals) were regularly replaced within the context of preventive maintenance.

Interim storage facilities for heat-generating radioactive waste are located at Gorleben, on the premises of the WAK GmbH in Karlsruhe, as well as at the interim storage Facility "*Zwischenlager Nord*" (ZLN).

At the Gorleben transport cask storage facility, not only spent fuel but also vitrified high-active waste from reprocessing is stored in transport and storage casks. Here, the same safety requirements apply as those described in the remarks on Article 5.

Spent fuel from operation of the Greifswald and Rheinsberg nuclear power plants, shut down in 1990, is stored in the transport cask storage facility of the interim storage facility "*Zwischenlager Nord*" (ZLN), where the vitrified waste from the VEK and fuel assemblies from KNK II and the nuclear ship Otto Hahn are stored as well.

In addition to the vitrified waste, there is heat-generating waste that is stored in a storage bunker at HDB with remote handling systems. The safety of these storage facilities has been checked as part of the licencing procedure and is subject to regulatory supervision over its entire operating period.

In principle, the procedure described below applies to all heat-generating radioactive waste.

One important 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 effectiveness 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 and storage 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 is not expected to be available before the year 2019, 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 on 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 licencing, monitoring and supervision by the competent local authority. The safety of the conditioning plants was assessed in the licencing 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 [1A-8], 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. Bavarian *Land* collecting facility as an example in Figure H-1) unless it is stored at the generator's site. According to § 9a AtG [1A-3], these *Land* collecting facilities have to be provided by the *Länder* for the radioactive waste generated 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 licencing documents (Annex II Part A StrlSchV) also require licencing according to § 7 StrlSchV by the competent *Land* authority. Checks during the licencing 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 waste 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 licencing 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 waste. 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 waste 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 waste 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: Bavarian *Land* collecting facility (left: storage building of the *Land* collecting facility in Mitterteich, right: *Annahmestelle Süd* (southern reception point) at the premises of the Helmholtz Zentrum München, Area I of the storage building with the mobile tank containers for storage of non-combustible liquids (chemical waste) and the storage area for solid waste) (Copyright: GRB)

When the waste is delivered to the *Land* collecting facility, it passes into the ownership of the latter. This also applies to raw waste. The waste generator'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 [1A-8]).

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 $46.5 \cdot 10^6$ m^3 of heaps and about $4.7 \cdot 10^6$ m^3 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 (*Strahlenschutzvorsorge-gesetz* [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 an administrative agreement between the Federal Government and the *Land* Saxony.

The BMU 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.

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.3.1. 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 licencing procedure is in principle not regulated by the Nuclear Licencing Procedure 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). Regulations of the Nuclear Licencing Procedure Ordinance are applied at least with respect to the EIA. Licencing is carried out by the competent licencing authority of each *Land* and follows the process described in the following.

The licencing 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 licencing 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 StrlSchV [1A-8], 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 und Article 6 (1) 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 participation of other authorities and, where applicable, the participation of authorities of other countries (cf. the remarks on Article 6 (1) iv).

H.3.2. 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, 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 licenced as a repository for radioactive waste with negligible heat generation, 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 site for further exploration in 1977 especially for heat-generating waste and has been explored from 1979 until 1 October 2000. After the expiry of the moratorium, the exploration work at the Gorleben salt dome was resumed in October 2010. With a preliminary safety analysis and a subsequent international peer review it is intended to establish the basis for a decision on the subsequent continuation of salt dome exploration for a repository especially for heat-generating radioactive waste.

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 non-mandatory guidance instruments are duly taken into account and applied with regard to radiological aspects (e.g. KTA 1301.1; see Rules of the Nuclear Safety Standards Commission (KTA)).

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 accessibility 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 licencing 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 StrlSchV [1A-8], 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 design basis accidents

In accordance with § 50 StrlSchV [1A-8], 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 a design basis accident. The licencing 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 a design basis accident occurring.

According to § 49 StrlSchV, the planning of structural or other technical protective measures against design basis accidents 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 rules and regulations and non-mandatory guidance instruments 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 reused 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 generated 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 waste or waste 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) will primarily be performed using the equipment required for operation and has already been considered in 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 licencing prerequisite, § 9b, para. 4 of the Atomic Energy Act (AtG) in conjunction with § 7, para. 2, subpara. 3 [1A-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 construction and operation of the installation”.

The SSK recommendation of 15 December 2010 on the Morsleben repository for radioactive waste (ERAM) states that the potential radiological exposure in the post-closure phase should not exceed an individual effective dose of 0.1 mSv per year in the case of probable developments and of 1 mSv per year in the case of less probable developments.

According to the safety requirements, it is to be demonstrated for a repository for heat-generating radioactive waste to be constructed that in the post-closure phase an additional effective dose in the range of 10 µSv per year in the case of probable developments and of 0.1 mSv per year in the case of less probable developments will not be exceeded.

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. 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 waste, 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 licencing 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 (cf. details in 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 waste requires a licence.

Being a special case, the construction of vitrification facilities must be licenced 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 licencing procedure pursuant to § 7 AtG are outlined in the remarks on Article 8, and apply mutatis mutandis to the licencing procedure for facilities for the vitrification of highly radioactive waste.

Whereas the licence pursuant to § 7 AtG combines the licences required for the construction 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 licencing procedure under § 7 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 reviews

Among other things, one licencing 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 [1A-8]). 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 licencing requirements, and are applied mutatis mutandis. During the course of verifying the licencing requirements, the competent licencing authority may call upon the services of independent

According to the Environmental Impact Assessment Act (UVPG) [1B-14], an environmental impact assessment is mandatory for nuclear facilities designed to store radioactive waste for more than ten years at a location other than that where they were generated, and for nuclear facilities requiring a licence under § 7 AtG [1A-3]. For facilities which provide for the storage of radioactive waste for less than 10 years, a basic requirement of performing an EIA is not defined. 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 licencing 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 waste whose activity inventories reach or exceed the values specified in § 53 StrlSchV (cf. details in Chapter F.5.1). 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-Verordnung*, 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 in particular 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 Protection 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 [1A-8].
- 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 licenced 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, among others, 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 [1A-8] 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 hazards have to be taken into account in the analysis of potential impacts:
  - natural external hazards, e.g. storm, rain, snowfall, freeze, lightning, flooding, forest fires, earthquakes, landslides,
  - man-induced external hazards, 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 licencing.

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 licencing 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 [1A-8] 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 geoscientific 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 7.2 of the “Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste” [BMU 10] stipulates the following:

> *“... Prior to any major decision pursuant to chapter 5.1, a comprehensive, site-specific safety analysis and safety assessment covering a period of one million years must be carried out*

... In particular, this assessment and the documentation thereof should include the following points:

- *The underlying final repository concept.*
- *The quality-assured collation of data and information from site exploration, research and development.*
- *The quality-assured implementability of requirements pertaining to technical barriers.*
- *The identification, characterisation and modelling of safety-relevant processes, together with confidence-building in this regard and qualification of the models.*
- *The comprehensive identification and analysis of safety-relevant scenarios and their allocation to probability categories pursuant to chapter 6.*
- *The representation and implementation of a systematic strategy for the identification, evaluation and handling of uncertainties."*

On this basis, a long-term statement on the integrity of the isolating rock zone and a long-term radiological statement are to be prepared as well as the proofs of the robustness of technical components of the repository system and the exclusion of criticality.

Assessment of impacts on the environment

§ 9b AtG [1A-3] stipulates that a plan approval procedure (licencing 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 11 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 Licencing Procedure 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) [1B-14] 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 AtG [1A-3], 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 licencing documents occur between the time of licencing until the commissioning of a facility for the treatment of radioactive waste, licencing under § 7 StrlSchV [1A-8] or § 7 AtG in the case of vitrification facilities is required (cf. details 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 licencing 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) [1B-14], 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. Licencing 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 licencing 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 amine 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 licencing 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 licencing 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 licencing 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 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 waste is 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 waste 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.

In-service inspections 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 in-service inspections are specified in a testing manual. The results of the in-service inspections 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 are 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 waste 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 [1A-8] 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 licencee to report safety-relevant incidents to the regulatory body is based on the appropriate application of the Nuclear Safety Officer and Reporting Ordinance (AtSMV) [1A-17] or on the stipulations in connection with licencing of the facility. The reporting duties and the reporting procedure are largely identical with the situation described in the remarks on Article 9 v.

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 waste. 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 licencing 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 licencee 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

For the closure of a repository, a plan approval notice must have been issued in accordance with the Atomic Energy Act.

Repository for heat-generating radioactive waste

The “Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste” stipulate that the decommissioning concept should be reviewed in line with the state of the art as part of the ten-yearly safety reviews, and updated where necessary. At the same time, the mining law is also to be applied. According to § 55, para. 1 of the Federal Mining Act (BBergG) [1B-15], operational plans for the construction and management of a facility 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.

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 licencing 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 AtG [1A-3], 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 licencing 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 licencing 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) [1B-14]. Meanwhile, documents for the plan approval procedure relating to the backfilling and closure of the Morsleben repository have been submitted to the competent licencing authority and laid down for public inspection. The issues raised by the objectors are currently under review. The responsible plan approval authority intends to conduct the public hearing in the period from 13 October to 10 November 2011.

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, 29 mine workings with a total volume of 935 000 m^3 have been filled by the end of February 2011. 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 in 2014 and to start the measures for decommissioning afterwards.

The Morsleben repository was designed and taken into operation at the time of the former GDR. A decommissioning 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 decommissioning concept were included. The decommissioning concept intends to hydraulically isolate the emplacement areas East Field, South Field and West Field, 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 waste 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 II mine

After the end of extraction operation, the former Asse II salt mine has been operated by the *Gesellschaft für Strahlenforschung* (today: Helmholtz Zentrum München) on behalf of the BMBF as a research mine. 124494 containers were emplaced as low-active waste between 1967 and 1978, among them about 15 000 so-called lost concrete shieldings (VBA) with higher-active waste, and 1293 containers with medium-active waste between 1972 and 1977. In parallel to the emplacement, tests with cobalt sources were performed to investigate the impacts of radioactive radiation on salt rock. Until 1985, there was further research into the development and demonstration of techniques for the emplacement of radioactive waste.

In 1997, the Helmholtz Zentrum München filed a framework operational plan for closure of the Asse mine on the basis of the BBergG [1B-15], 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.

The Helmholtz Zentrum München provided an operational plan for closure and a safety report on 29 January 2007. The licencing authority, LBEG, and their independent experts had then started the formal detailed review process of the technical documents that were filed in support of the safety report. The operational plan for closure with the safety report has meanwhile been withdrawn by the BfS.

On 4 September 2008, the competent Federal Ministries BMU and BMBF and the Lower Saxony Ministry for the Environment and Climate Protection agreed that BfS will take over responsibility for the closure as future operator. The Asse II mine will procedurally be treated as a repository in the future.

Since 1 January 2009, the Federal Office for Radiation Protection (BfS) has been the operator of the repository mine Asse II. This was preceded by the decision of the Federal Government of 5 November 2008, to transfer the Asse II mine, which had so far been operated according to mining law, to the area of application of nuclear law and to operate it in future as a radioactive waste repository according to § 9a of the Atomic Energy Act (AtG [1A-3]). The BfS was charged with taking over the facility on 1 January 2009 from Helmholtz Zentrum München – *Deutsches Forschungszentrum für Gesundheit und Umwelt* (HMGU), operating and closing it according to the provisions applying to repositories. As an administrative assistant for the BfS, the federally owned Asse-GmbH was founded who is operating the mine on behalf of the BfS.

An influx of solution in the area 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 currently enter at a quantity of 12.5 m^3 per day, are collected. The chemical composition is largely constant. During the operating phase, the collected influent solution (about 10 m^3/d) is pumped to the surface and is put at the disposal of the K + S AG for further use. The delivery of influent saline solutions to the Mariaglück mine near Höfer of the K + S AG was prohibited by the licencing authority in June 2008 due to the elevated tritium levels. The tritium contamination was due to unfavourable storage conditions and the resulting contact with tritium-containing mine air. As a result, the storage capacities of the Asse II mine above ground and underground were exhausted by the beginning of 2009. The introduction of a new method for the management of the saline solutions led to a significant reduction of the tritium contamination so that it was possible to resume delivery of the influent solutions to the Mariaglück mine.

A small amount of the collected influent solutions (about 2 m^3/d) has contaminants that originate from contact with the stored waste and make a transfer to the surface impossible. These solutions can be used underground for the production of backfill material for backfilling of cavities.

In order to stabilise the mine against continuing rock movements from the overburden, the 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 m^3) fill material was inserted into the southern flank of the Asse II mine. The Helmholtz Zentrum München has then started to fill the shafts and drifts below the disposal areas. These sections were filled with rock salt and magnesium chloride solution to permanently protect the carnallitic potash salt occurring in the mine against future dissolution by entering sodium chloride solution.

Due to the high excavation degree in the southern flank of the salt structure and the influent solutions in the mine, a prediction on the deformation rate of pillars and stopes can only be made to a limited extent. Therefore, after having taken over the operatorship, the BfS first performed measures to improve stability and precautionary measures regarding the influent solutions. In addition, an emergency planning was set up for the case that the inflow of solutions reaches an uncontrollable level.

As part of the measures for hazard control, the complete filling of the remaining cavities in the former mine workings of the southern flank, where no radioactive waste has been emplaced, was initiated. At the time of taking over of the operatorship, nearly all mine workings of the southern flank were filled with salt rock (crushed salt). However, adequate stabilisation could not be achieved this way, since crushed salt has a high proportion of trapped air. Compression (compaction) of the injected material led to the formation of horizontal clefts at the roofs of the mine workings with an average height of 35 cm. Since 2009, these remaining cavities have been successively filled with a special type concrete consisting of rock salt, magnesium oxide and magnesium chloride solution (Sorel concrete). The aim of the measure is to slow down rock deformation thus improving the safety situation. Emplacement areas have not been affected by the backfilling measures taken so far.

Since 8 July 2010, the Asse II mine has a licence for the handling of radioactive substances pursuant to § 7 of the Radiation Protection Ordinance (StrlSchV [1A-8]) for keeping the mine open, granted by the Lower Saxony Ministry for the Environment and Climate Protection upon application of the BfS of 21 April 2011.

Different possibilities of actions for the safest possible closure of the Asse II were examined and evaluated with public participation and the involvement of various authorised experts. In the so-called "comparison of options", three possible closure options were described, analysed and evaluated on the basis of predetermined criteria. The options considered were:

- the retrieval of the radioactive waste,
- the relocation of the radioactive waste to a deeper part of the salt dome,
- the complete backfilling of the mine without removal of the radioactive waste.

As a result of the comparison of options, the BfS concluded that, taking the present state of knowledge into account, the preferred closure option would be the retrieval of the waste. With this option, the waste must first be retrieved and transported to above ground, conditioned, preliminary stored, and then transported to a suitable repository.

Due to the limited knowledge about the condition of the waste and the emplacement chambers, the realisation of this closure option is fraught with uncertainties. So, the condition of the drums with the radioactive waste may be much worse than assumed. The drums may have been severely damaged and no longer be manageable to the extent assumed. To clarify these uncertainties, there will, firstly, be a test phase (finding of facts), divided into three steps:

- In a first step, there will be drillings into two emplacement chambers at the 750 m level to take gaseous, liquid and solid samples.
- In a second step, these emplacement chambers will be opened to assess their condition and the condition of the packages located in them.
- In a third step, it is intended to recover first waste packages from the two emplacement chamber by way of trial.

All three steps must be carefully planned. In particular, the necessary technical and organisational safety measures have to be observed so that neither the staff in the mine nor the people above ground and the environment are at risk due to increased radiation. On 21 April 2011, Lower Saxony Ministry for the Environment and Climate Protection granted the licence for drilling into the two selected emplacement chambers at the 750 m level upon application of the BfS.

If the uncertainties can be eliminated by way of fact finding, retrieval can start after modernisation of the hoisting plant and provision of an aboveground interim storage facility.

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 institution al controls such as monitoring or access restrictions are carried out, if required;

iii) if, during any period of active institution al control, an unplanned release of radioactive materials into the environment is detected, intervention measures are implemented, if necessary.

H.7.1. Documentation

The official plan approval for the Konrad repository includes the regulations governing the post-operational period. 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

The "Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste" stipulate that following decommissioning of the repository, evidence preservation and control measures must be carried out. Prior to the completion of sealing work, it is necessary to determine which measures are to be carried out, which organisation shall perform them, and which resources will be made available for this purpose. For the period after sealing, administrative precautions should be implemented to ensure, as effectively as practically possible, that no human activities which could endanger the permanent containment of the waste are carried out in the vicinity of the repository.

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."*

Should the results from routine surveillance so require, counteractive action may be initiated by means of intervention on the part of the authorities. The procedures for the Morsleben repository and the Asse II mine have 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 repository, 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 closures of the Morsleben repository and the Asse II mine are currently in the planning phase, and therefore plan approval is not yet available.

Exhaust air and surroundings of the Morsleben repository and the Asse II mine are continuously monitored by the operator and by an independent measuring institution. The programmes required for it are based on the "Guideline concerning Emission and Immission Monitoring of Nuclear Installations" (REI).

Measurements and measured values exist for

- gamma dose rate,
- aerosol activity,
- soil samples and
- grass samples.

The most important data of the operator's own environmental monitoring and monitoring by an independent measuring institution are published in annual reports. Quarterly reports supplement the documentation.

I. Transboundary movement

This section deals with the obligations according to Article 27 of the Convention.

Developments since the third review meeting:

In Mai 2009 the revised version of the Nuclear Waste Shipment Ordinance (AtAV) [1A-18] entered into force. The ordinance serves for the implementation of Directive 2006/117/EURATOM of 20 November 2006 [EUR 06] on surveillance and control of shipment of radioactive waste and of spent fuel. The essential modifications to former provisions are on the one hand the taking into account of spent fuel into the scope of application of the Regulation and on the other hand the detailed regulation of the licencing and notification procedures.

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 licencing transboundary movement

Transboundary movements of spent fuel and radioactive waste are according to Directive 2006/117/EURATOM [EUR 06] subject to licencing in Germany (and in other Member States of the EU). Current German legislation requires that the delivering party (Le. 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 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 spent fuel and radioactive waste from other EU states to Germany, the licencing authority in the delivering country shall be responsible; however, the BAFA is also consulted. The BAFA can attach special provisions to its approval or, if necessary, can refuse the approval on reasoned grounds.

Transboundary movements of spent fuel 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. This applies equally for the granting of approval in case of consultation.

I.2.1. Authorisation of transboundary movement and coordination with state of destination

Spent fuel

Essential for all transboundary movements of spent fuel to, through or from the Federal Republic of Germany is the “Ordinance on the Transboundary Movement of Radioactive Waste and Spent Fuel Assemblies” (AtAV [1A-18] by which the Directive 2006/117/EURATOM [EUR 06] is implemented in national law; according to § 6 and 7 of the AtAV is the BAFA the competent authority for this. 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.

It primarily comprises the following provisions:

<u>Transboundary movement within the European Community</u>

The holder respectively the sender 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 B-1 is the application form. The competent authority forwards a copy of this section together with section B-2 (“Acknowledgement of receipt of the application form for transboundary movement of spent fuel”) and Section B-3 (“Approval or refusal of the approval for transboundary movement of spent fuel by the competent authority”) to this competent authority in the State of destination (which in the case of shipments to Germany is the BAFA). This Section B-3 is only approved by the BAFA and mailed back to the competent licencing authority provided both the consignee and his competent supervising authority have likewise given their consent to the proposed shipment. Section B-4a (“Licence for transboundary movement of spent fuel”) can then be issued and handed over to the applicant.

During a shipment, all documents must be carried, including section B-5 (“Description of delivery of spent fuel and the list of the packages) and section B-6 (“Acknowledgement of receipt for spent fuel”).

In advance of each shipment all the aforementioned documents must be transmitted to all authorities concerned. 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 B-5 and B-6.

Transboundary movement to or from states which are not members of the European Community (Third Countries)

In case of shipments from Germany to a third country, the BAFA will only grant a licence to the holder or sender of the spent fuel if 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 spent fuel or has notified such handling in accordance with an existing obligation.

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 end anger Germany's international obligations in the field of nuclear power or its internal or external security.

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 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 licencing procedure under foreign trade law.

Radioactive waste

Each transboundary movement of radioactive waste is subject to the provisions of the Directive 2006/117/EURATOM [EUR 06]. This Directive with the Ordinance on the Transboundary Movement of Radioactive Waste (AtAV) [1A-18] as already mentioned above has been transformed into national law. It primarily comprises the following provisions:

Transboundary Movement within European Community

The holder respectively the sender 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 B-1 is the application form. The competent authority forwards a copy of this section together with section B-2 ("Acknowledgement of receipt of the application form for transboundary movement of spent fuel") and Section B3 ("Approval or refusal of the approval for transboundary movement of spent fuel by the competent authority") to this competent authority in the State of destination (which in the case of shipments to Germany is the BAFA). This section B-3 is only approved by the BAFA and mailed back to the competent licencing authority provided both the consignee and his competent supervising authority have likewise given their consent to the proposed shipment. Section B-4a ("Licence for transboundary movement of spent fuel") can then be issued and handed over to the applicant.

During a shipment, all documents must be carried, including section B-5 ("Description of delivery of spent fuel and the list of the packages) and section B-6 ("Acknowledgement of receipt for spent fuel").

In advance of each shipment all the aforementioned documents must be transmitted to all authorities concerned. 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 B-5 and B-6.

Transboundary movement to or from states which are not members of the European Community (Third Countries)

In case of shipments from Germany to a third country, the BAFA will only grant a licence to the holder or sender of the spent fuel if 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 spent fuel or has notified such handling in accordance with an existing obligation.

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 end anger Germany's international obligations in the field of nuclear power or its internal or external security.

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 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 licencing procedure under foreign trade law.

I.2.2. Transboundary movement through states of transit

In the case of transit through Germany of spent fuel or radioactive waste the provisions of the AtAV [1A-18] also apply. Supervision of the transit of such spent fuel is the additional 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 or spent fuel, the BAFA must be consulted under the provisions of Directive 2006/117/EURATOM [EUR 06] or of the AtAV; these transits therefore are 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 and of radioactive waste will only be licenced 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.

I.2.4. Compliance with safety provisions by the consignee in the state of destination

In the case of deliveries of spent fuel 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 and spent fuel 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 2006/117/EURATOM [EUR 06] (in this respect, cf. the comments on Article 27 (1) i and ii).

I.2.5. Possibility of re-import

In accordance with the Directory 2006/117/EURATOM [EUR 06] respectively the AtAV [1A-18], the re-import of spent fuel or radioactive waste 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 or spent fuel under the AtAV in conjunction with Directive 2006/117/EURATOM facilitates the option of return shipment in case the envisaged delivery cannot be completed:

According to § 8, para. 1, subpara. 3 AtAV, shipment to another EU Member State will only be licenced provided measures are taken to ensure that the radioactive waste or the spent fuel will be taken back by the original owner/sender if delivery cannot be completed or the provisions for its shipment cannot be met.

According to § 9, para. 1, subpara. 4 AtAV, shipment to a third country will likewise only be licenced provided measures are taken to ensure that the radioactive waste or spent fuel will be taken back by the original owner/sender if delivery cannot be completed or the provisions for its shipment cannot be met.

According to § 10, para. 1, subpara. 3 AtAV [1A-18], shipment from a third country into Germany will only be licenced provided the domestic consignee of the radioactive waste or spent fuel has reached a binding agreement with the foreign owner/sender of the radioactive waste or spent fuel, with the consent of the competent authority in the third country, that the foreign owner/sender will take back the radioactive waste if the shipment process cannot be completed.

Finally, according to § 14, 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 or spent fuel will be taken back by the original owner/sender 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 [1A-18] 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 Rheinschifffahrtsakte*) 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 internationalen 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 treatment

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. The Directory 2006/117/EURATOM [EUR 06] applies.

I.4.4. Shipment of spent fuel for reprocessing

This right remained unaffected until 30 June 2005. From this date on, to ship any German spent nuclear fuel from nuclear power plants for fission of nuclear fuels for the commercial generation of electricity to a nuclear power plant for reprocessing of irradiated nuclear fuels 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 generated from the reprocessing of German spent fuel to Germany.

J. Disused sealed sources

This section deals with the requirements of Article 28 of the Convention.

Developments since the Third Review Meeting:

The amount of data of sealed radiation sources in the HASS register, maintained by BfS, has increased appreciably. The HASS register is continuously further developed with regard to accessibility and usability while maintaining a high safety level.

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

Nearly 100 000 sealed sources are used in research, trade, industry, medicine and agriculture in Germany. The most common field of application for sealed sources in the industry are calibration of measuring devices, materials testing, irradiation and sterilisation of products, as well as level and density measurement. In medicine the sealed sources are mostly used for radiotherapy and for irradiation of blood. The radionuclides in sealed sources are mostly Co-60, Ir-192, Cs-137, Sr-90 and Am-241 whose activity reaches some kBq for test and calibration emitter and some TBq of radioactive sources for irradiation facilities.

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 licencing 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 09]. 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. In the following the experiences made with the HASS register at the BfS and the international context of control of radioactive sources are described.

High-activity sealed radioactive sources (HASS) and the HASS register at the BfS

Based on the 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) [1F-22] the Law on the Control of High-Activity Radioactive Sources [1A-23] entered into force in August 2005. The scope of the Council Directive 2003/122/EURATOM and of the Law [1A-23] is limited on high-activity sealed radioactive sources.

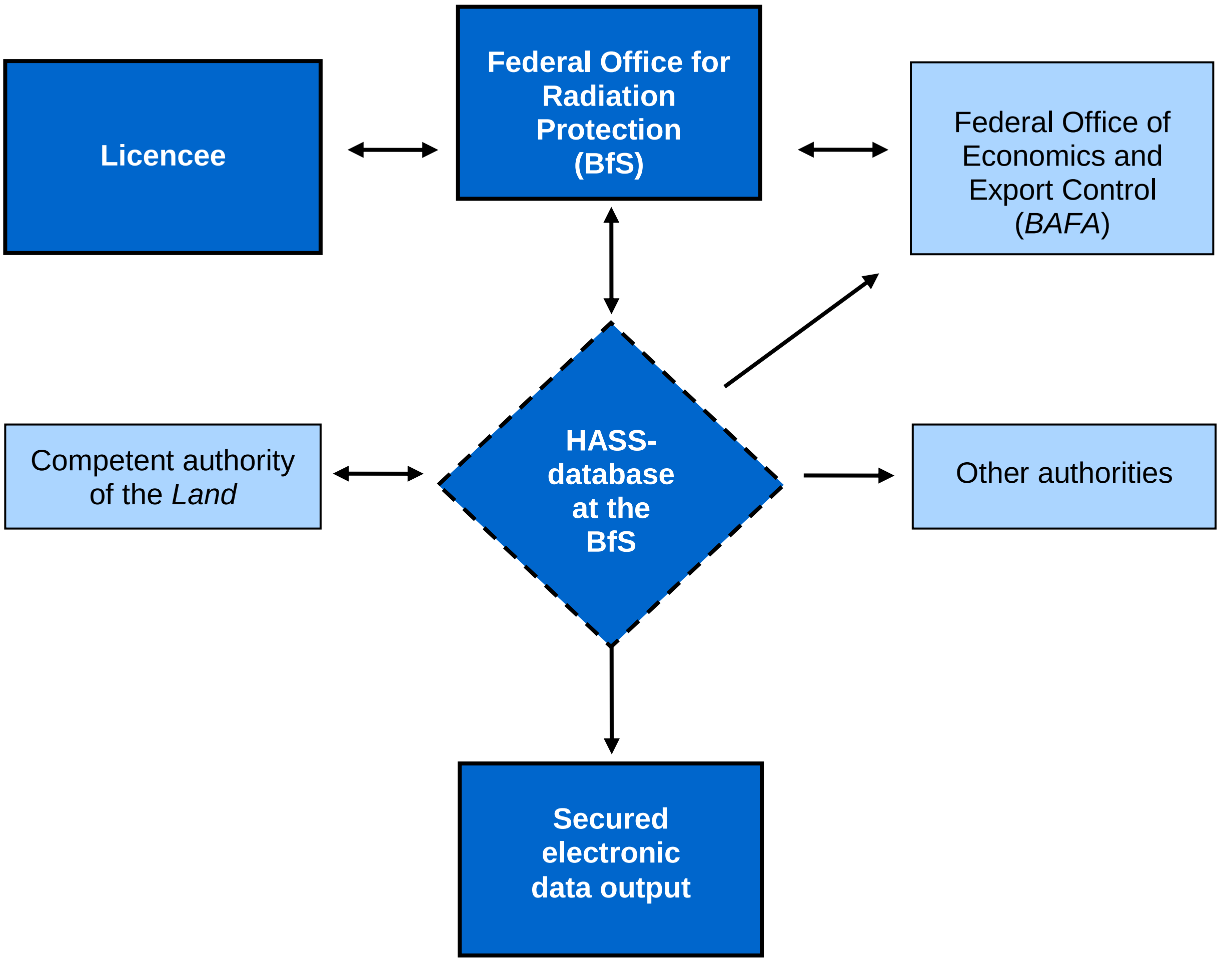
The implementation of the Law on the Control of High-Activity Radioactive Sources [1A-23] has entailed substantial changes to the Atomic Energy Act (AtG) [1A-3], the Radiation Protection Ordinance [1A-8], the Ordinance on the Financial Security Pursuant to the Atomic Energy Act (AtDeckV) [1A-11] as well as the Nuclear Waste Shipment Ordinance (AtAV) [1A-18].

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 licencee to the HASS. As these modifications were already mentioned in the national report for the third Review Meeting, in the following especially the experiences of using the register are described.

Responsibilities of people participating in the database can be summarised as follows in the description and in Figure J-1.

- Licencee: Notification regarding the acquisition, the transfer and the use of HASS register (including loss or discovery) to the BfS. The licencee transmits the data using the standardised data sheet of Appendix XV StrlSchV in secured electronic form. Under safety aspects the licencee has no direct access to the database.
- The competent authority of the individual *Land*: verification of the data, the loss or discovery of HASS, reports and analyses transmitted by the licencing authority. The authority can access to the database.
- The BfS: operation and maintenance of the database, preparation of reports and analyses, check on the plausibility of data, data entry, providing users with advice, development of software and hardware. The BfS is the actual user of the database.
- Other authorities: reports and analyses, if security situations occur. These authorities have a read-only access.

Figure J-1: Operation of the HASS register and communication with BAFA via encrypted data transfer on the internet [BfS 09A]



The operation safety of the HASS database is guaranteed as follows:

- No direct access to the database for the licencee, only via SSL and login user name and password;
- Access for the *Land* authority via SSL and certificate, login user name and password, read and write access;
- Access for other authorities via SSL and Certificate, login user name and password, read-only access;
- The personnel of the BfS is cleared for access to secret information;
- The PCs at the BfS where the HASS database is installed are limited accessible.

The HASS database is in operation since July 2006 and meets the requirements of the European HASS directive mentioned above. The system is approved by the licencees and authorities and is subject to constant further development in regard to accessibility, also for the licencee, and usability while maintaining a high safety level.

The current status of radionuclides and activities captured in the HASS database is shown in Figure J-2 and Figure J-3. It becomes obvious that Ir-192, Co-60 und Cs-137 are the most frequent nuclides with the highest activities.

Figure J-2: Radionuclides in the HASS database at the BfS in 2009 [BfS 09A]

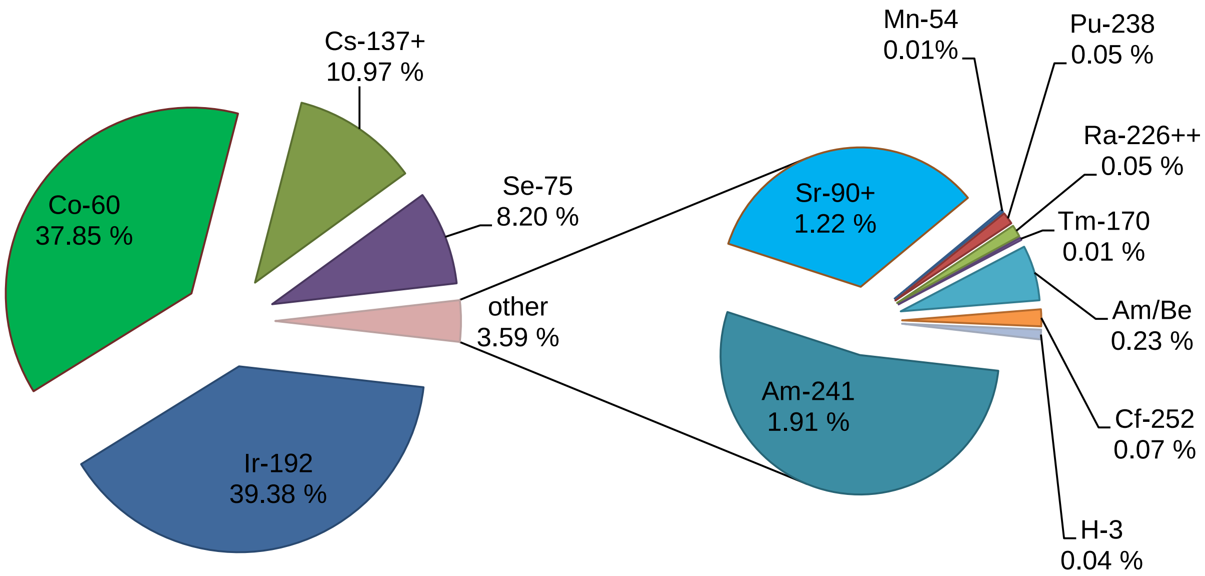
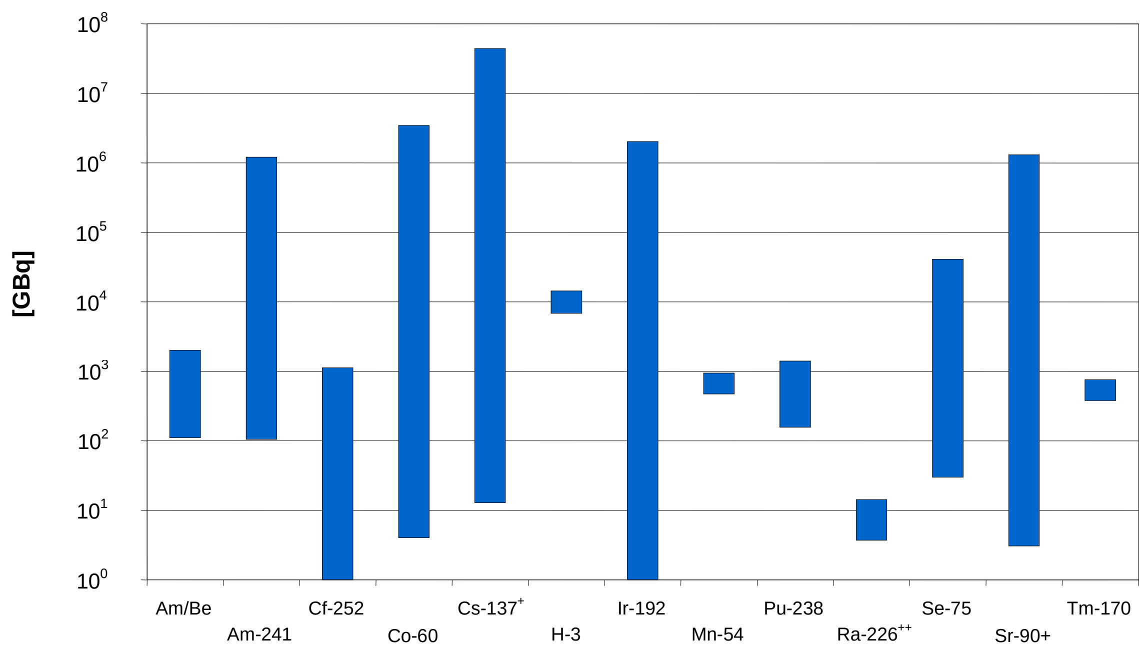


Figure J-3: Activities in the HASS database at the BfS in 2009 [BfS 09A]



According to § 69, para. 5 StrlSchV [1A-8], 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 licencee or have to be disposed of as radioactive waste or kept in interim storage. According to § 69a StrlSchV manufacturers and carriers are obliged to take the sources back.

General requirements for radioactive sources

The use of sealed radioactive sources requires a licence according to § 7 StrlSchV [1A-8]. 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, among others according to § 7 StrlSchV, may only be transferred to persons who are in possession of the requisite licence. 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 § 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 I 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 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 [1F-22] into national legislation and include the relevant recommendations and the IAEA Guidance (see Chapter J.2.1 for international aspects).

Regulations for loss and discovery of radioactive sources

§ 71 StrlSchV [1A-8] 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 (see the abovementioned remarks about the HASS register). 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.

J.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. These regulations fully take into consideration the generally high risk potential of radioactive sources and allow implementing the requirements of the Code of Conduct [IAEO 04] which deals in §§ 23 to 29 with the import and export of radiation sources and 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. The Regulations for the transboundary shipment contained in §§ 19 to 22 StrlSchV [1A-8] do also apply to HASS.

It needs to be mentioned that shipment within the EU is not subject to licencing 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 [EUR 93]. 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 licencing or notification, e.g. for re-entry of a radiation source from a non-EU country, the competent authority according to § 22 AtG [1A-3] 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 licencee 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. 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.

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:

(Article4)

(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 [EUR 93]).

(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 can be valid for 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.

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.2.1. International aspects

The German regulations take into account the fact that the safety of radioactive sources has a strong international dimension. Of particular importance in this connection are orphan sources, as the global scrap trade can contribute to their unintended spread. Radioactive sources hidden in scrap present a much higher potential risk than contaminations with naturally occurring radioactive material (NORM) or other radioactive materials. Therefore the Federal Government welcomes all efforts aimed to reduce the potential risk and especially to avoid the spread of radiological sources in the global scrap trade.

Examples:

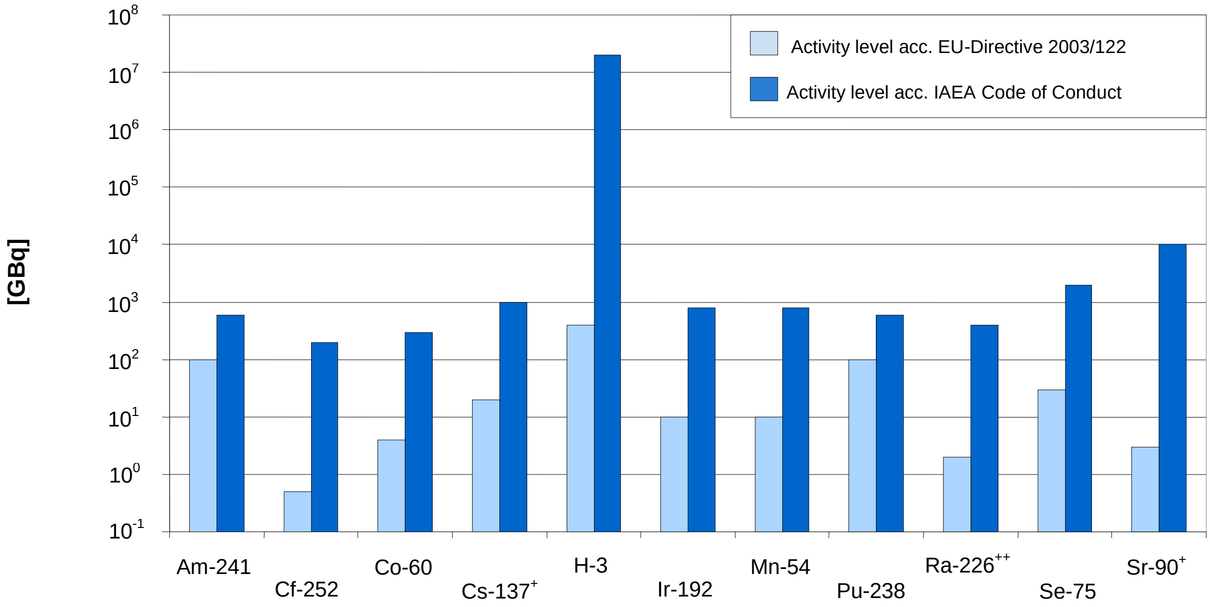
- The information system operated by the IAEA for transmission of data about loss of radioactive sources worldwide,
- Organisation of international meetings and other forums for information exchange between experts, as for example the *International Conference on Control and Management of Inadvertent Radioactive Material in Scrap Metal* in Tarragona (Spain) in February 2009, as this may lead to coordinated and harmonised international strategies,
- Development of an international Convention regarding the transboundary shipment of scrap and composite products (International Agreement concerning the Transboundary Movement of Scrap Metal and Semi-Finished Products of the Metal Recycling and Production Industries containing Radioactive Material), which is being prepared at the moment under leadership of the IAEA,
- The efforts of individual countries, in creating open regulations of cost transfer for disposal of radiological sources discovered in scrap, to ensure that discoveries of radiological sources are reported to the authorities and not suppressed in fear of high disposal costs. In Spain this is transmitted by means of the “Spanish Protocol”, the strategy of which is taken over by South American countries.

The final report of the conference in Tarragona expresses that by the adoption of a binding convention between the countries a standardisation of the strategy against unintended transboundary shipment of radioactive materials contained in scrap could be achieved. The General Conference of the IAEA has taken notice of this explanation and designated the IAEA secretary with the preparation of such a convention. This preparation has started in July 2010 by a working group of international experts with German participation. Germany will continue to support this development in the future.

The international data exchange facilitates the worldwide control and tracking of radioactive sources. Within the EU important prerequisites regarding the international data exchange are fulfilled by the abovementioned rules, in particular the ordinances 1493/93/EURATOM [EUR 93] and 2003/122/EURATOM [1F-22]. Agreements on an electronic data exchange format as well as the consideration of experiences of the Member States of the European Union are relevant objectives in the future.

Further, it needs to be mentioned that there are partly deviations between the definition of high-active radioactive sources according to the ordinance 2003/122/EURATOM [1F-22] and the definition according the Code of Conduct of the IAEA. Thus it is more difficult to achieve harmonised approaches worldwide. Figure J-4 provides a comparison of the threshold values above which a radioactive source is classified as HASS for relevant radionuclides.

Figure J-4: Activity values for HASS according to the European and international regulatory framework



The applicable threshold values in the EU are lower than the threshold values of the IAEO. Therefore, every radioactive source which is internationally classified as HASS is also classified as HASS in the EU. As this is not the case in a negative sense, Germany stands for an international harmonisation in this area.

K. Planned activities to improve safety

K.1. Disposal of heat-generating radioactive waste

After the expiry of the moratorium on 30 September 2010, the exploration work at the Gorleben salt dome was resumed. With a preliminary safety analysis and a subsequent international peer review it is intended to establish the basis for a decision on the subsequent continuation of salt dome exploration. With the subsequent peer review it is intended to review the safety assessment of the Gorleben salt dome, based on the preliminary safety analysis, as a medium for a repository for heat-generating radioactive waste with regard to the state of the art in science and technology, and to document this review in a traceable and transparent manner.

This review will mainly serve to determine

- whether the repository concept is based on the best technologies available,
- whether safety assessment of the Gorleben site was performed according to the international state of the art in science and technology, and
- whether the safety case can be developed in a transparent and traceable manner.

K.2. COUNCIL DIRECTIVE 2011/70/EURATOM of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste

Germany has welcomed the initiative of the Commission of the European Union to present a directive for management of radioactive waste and spent fuel [EUR 10]. Within the framework of the ENSREG (European Nuclear Safety Regulators Group), Germany intensively participated in the technical preparation of this Directive. The Directive supplements the Directive of the European Union on the safety of nuclear installations (2009/71/EURATOM) [1F-5] and represents the implementation of the second part of the nuclear package presented by the Commission in 2003.

One focus of the Directive is the requirement for every member state to establish a national programme that includes comprehensive measures for the sustainable management of radioactive waste and irradiated fuel assemblies already existing and expected to arise in future. This programme aims at establishing and increasing transparency and traceability for the public regarding decisions necessary for the management, including the disposal of radioactive waste and irradiated fuel assemblies. Each national programme will be reviewed by an international group of experts and further developed at regular intervals. This ensures transparency and traceability for further proceedings and full participation of the citizens on the basis of sound knowledge.

The Directive supplements the provisions of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management and implements them at European level. Thus, the aim is that reporting related to the Joint Convention and within the framework of the Directive supplement each other.

Germany will rapidly transpose COUNCIL DIRECTIVE 2011/70/EURATOM [EUR 11] of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste into national law and present a national programme within the timeframe specified by the Directive by 2015.

K.3. Interim storage of spent fuel and radioactive waste

Based on the recommendations for guidelines for the performance of periodic safety reviews for interim storage facilities for irradiated fuel assemblies and heat-generating radioactive waste storage casks [4-5] adopted by the ESK, it is intended to test the application of these guidelines in a two-year test phase for two selected interim storage facilities.

For the interim storage of operational waste and especially of waste generated from the dismantling of decommissioned nuclear facilities, storage facilities have been or will be constructed at the places of its origin, ensuring its longer-term safe keeping until it can be dispatched to the Konrad repository in special waste packages.

K.4. Updating of the German rules and 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 is according to 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 of spent fuel and radioactive waste (cf. details in Chapter K.5). The review of the relevant German rules concluded in 2009 showed that there are differences compared to the safety reference levels of the WENRA WGWD in the regulatory equivalence of the safety issues management system, emergency planning and periodic safety review. In these areas, the result of the review of the rules and regulations requires adjustments of the German non-mandatory guidance instruments. The respective national action plan has been prepared. In a first step, the ESK developed the recommendations for guidelines for the performance of periodic safety reviews [4-5] mentioned in Chapter G.2.2.

Currently, the safety guidelines for interim waste storage facilities [4-3] and for dry interim storage of irradiated fuel assemblies in storage casks [4-2] are being revised by the ESK.

K.5. Western European Nuclear Regulators' Association – WENRA – harmonised approaches in the European nuclear regulations regarding the areas of interim storage, decommissioning and disposal

The objective of the current 17 WENRA Member States is the joint development of safety criteria in the field of nuclear safety in Europe within national responsibility, but also in the fields of interim storage of spent fuel and radioactive waste, the decommissioning of nuclear installations and safety regarding the disposal of low-, medium- and high-level radioactive waste.

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 to constantly continue developing the general regulatory safety approaches of the Member States included in the respective national rules and regulations.

The Working Group on Waste and Decommissioning (WGWD) that was set up especially for these purposes by WENRA in 2002 defined requirements in the form of safety reference levels in the areas of interim storage of spent fuel and radioactive waste, decommissioning of nuclear installations, and the disposal of spent fuel and radioactive waste. These safety reference levels were adopted for the first time in the Version 1.0 of December 2006 (interim storage) and March 2007 (decommissioning) by WENRA. Version 1.0 of the report for the disposal of spent fuel and radioactive waste is planned for late 2011.

Version 1.0 of the "Waste and Spent Fuel Storage Safety Reference Levels Report" [WENRA 06] contains 77 safety reference levels covering the topics of safety management, design, operation and safety verification for interim storage. Version 1.0 of the "Decommissioning Safety Reference Levels Report" [WENRA 07] deals with 81 safety reference levels covering the topics of safety management, decommissioning strategy and planning, conduct of decommissioning and safety verification for 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 deviations between national approaches and the common approach reflected in the safety reference levels. These deviations serve as a starting point for the further development of national regulations. For this purpose, the WENRA Member States develop national action plans serving to eliminate deviations or deficiencies identified within national responsibility. In the meetings of the WGWD, WENRA Member States report on the progress in implementing the national action plans.

Benchmarking of the safety reference levels for interim storage

In the case of the safety reference levels for interim storage, the benchmarking process compassed two main steps of evaluation: 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, Version 1.0 of December 2006, was performed. In this context, the respective nuclear regulations for interim storage facilities for radioactive waste and for interim storage facilities for spent fuel were considered separately. The assessment is based on the classifications "A" (meets the requirements of the safety reference levels), "B" (differences exist but can be justified under safety aspects and thus do not require any adjustment) and "C" (differences exist and should be considered for an improvement in terms of the safety reference levels).

In working groups of four countries each, the national self-assessments were subjected to a detailed examination by the other countries and corrected where necessary (benchmarking process). From the results of benchmarking it is derived where there is a need of harmonisation in the national regulations ("C" rating). Based on these findings, an action plan was developed in which each country explains to the WGWD by means of which measures the identified deficiencies with respect to the common approach are to be resolved and implemented in the national regulations.

For Germany, it showed within the framework of the requirements for interim storage that there is potential for improvement in particular in the safety issues management system, emergency planning and periodic safety review. However, it has to be noted that the first review showed that around 80 % of the requirements of the safety reference levels of the WENRA WGWD were covered by the German regulations.

The action plan presented by Germany provides the removal of regulatory deficiencies compared to the common approach in the above issues. In this respect, concrete measures have been initiated. On behalf of the BMU, the ESK prepared recommendations for guidelines for the performance of periodic safety reviews for interim spent fuel storage facilities. Start of trial implementation in practice is planned for 2011 as part of pilot procedures in selected facilities.

The harmonisation of the other aspects identified as not adequately regulated according to the WGWD benchmarking process is to be performed within the framework of the revision of the safety guidelines for interim waste storage facilities [4-3] and for dry interim storage of irradiated fuel assemblies in storage casks [4-2].

As a result of the benchmarking process, the "Waste and Spent Fuel Storage Safety Reference Levels Report" has undergone a comprehensive revision by the WGWD. In its revised version 2.0 published in March 2010, the report now contains 61 safety reference levels [WENRA 10].The report was disseminated to stakeholders to provide comments on the document. Following the receipt and review of comments by the WGWD, the final version 2.1 has been prepared and published in February 2011.

The necessary improvements for the individual WENRA Member States can be derived from the results of all assessments. Current scheduling provides that the implementation of the national action plans with specific regulatory measures for a harmonisation to the safety reference levels will be completed by the end of 2012.

Benchmarking of the safety reference levels for decommissioning

In the case of the safety reference levels for decommissioning, Version 1.0 of March 2007, the national assessments were only performed for the regulations relevant with regard to decommissioning. The performance of assessments of the national decommissioning practice was optional for the Member States, since, from the point of view of the WGWD, an analysis of the respective decommissioning practice would not provide significant contributions to the advancement of the national rules and regulations.

With the help of representatives of the German *Länder*, the assessment of the German rules and regulations was performed in 2007 and 2008 and presented to the sub-working group of the WGWD. Following the end of the consultation process in early 2009, deviations were identified for 23 % of the safety reference levels ("C" rating), among others in the subject areas decommissioning concept for research reactors, site strategy for decommissioning, development of a decommissioning concept during plant operation and periodic safety review during decommissioning. The national action plan will probably be presented by the end of 2011. Currently, the WGWD expects implementation of the national action plans by the end of 2013.

Besides the assessment of regulations relevant for decommissioning, Germany performed an analysis of some decommissioning projects with the support of the licencees of various plants under decommissioning and the competent licencing and supervisory authorities. The objective was to review the implementation of selected safety reference levels in the German decommissioning practice, particularly those that were rated "B" or "C" within the framework of the assessment of the rules and regulations. Another objective was to identify potential for further development of the safety reference levels. The analysis showed that in the considered decommissioning projects, the selected safety reference levels are considered in accordance with the provisions of the regulations and in some cases beyond them. The analysis also yielded findings on the further development of the safety reference levels introduced as proposal by Germany in the current revision process for the "Decommissioning Safety Reference Levels Report" (Version 2.0).

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 and their inventories (Table L-1),
- Wet storage facilities for spent fuel and their inventories (Table L-1),
- Central interim storage facilities for spent fuel (Table L-2),
- Pilot conditioning plant at Gorleben (Table L-3),

Interim storage facilities for spent fuel for which licences have been applied for or granted under § 6 of the Atomic Energy Act [1A-3] (Table L-4).

Table L-1: Wet storage facilities for spent fuel and their inventories, as at: 31 December 2010

Reactor, site	Licenced 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	272	131	25
Krümmel	1 690	832	566	47
Brokdorf	768	562	51	276
Unterweser	615	404	13	210
Grohnde	768	568	71	271
Emsland	768	569	231	182
Biblis A	582	382	40	183
Biblis B	578	381	68	167
Obrigheim 3)	1 210	1 210	868	100
Philippsburg 1 4)	948+169	356+169	73+158	49+2
Philippsburg 2	716	523	138	208
Neckarwestheim 1 5)	310+128	133+128	25+28	39+36
Neckarwestheim 2	786	463	33	231
Gundremmingen B	3 219	2 422	310	367
Gundremmingen C	3 219	2 423	365	358
Isar 1	2 232	1 430	288	199
Isar 2	792	557	63	264
Grafenrheinfeld	715	496	60	234

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
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, 100 of which occupied, 28 vacant

Table L-2: Central storage facilities for spent fuel and heat-generating radioactive waste, as at: 31 December 2010

Site	Types of containers	Licenced 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 containers 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) (6 storage positions) 305 CASTOR® THTR/AVR (48 storage positions) 18 CASTOR® MTR 2 (7 storage positions)
Gorleben	CASTOR® Ia, Ib, Ic, IIa, V/19, V/52, TN 900/1-21 and CASTOR® HAW 20/28 CG, up to Series no. 15, CASTOR® HAW 20/28 from Series no. 16 onwards, TS 28V and TN 85, TS 28V and CASTOR® HAW28M 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 12 TN 85 with 336glass canisters 1 TS 28 V with 28 glass canisters 10 CASTOR® HAW28M with 280 glass canisters
Greifswald (ZLN)	CASTOR® 440/84 at 80 storage positions	585 Mg HM $7.5x10^{18}$ Bq	6 CASTOR® 440/84 from Rheinsberg (48 Mg HM) 59 CASTOR® 440/84 from Greifswald (535 Mg HM) 4 CASTOR® KNK with fuel rods from Karlsruhe and the research vessel ”Otto Hahn” 5 CASTOR® HAW 20/28 CG with 140 glass canisters from VEK
Jülich	CASTOR® THTR/AVR (max. 158 containers)	225 kg nuclear fuel; no activity limit	approx. 290 000 AVR fuel assembly spheres in 152CASTOR® THTR/AVR

Table L-3: Pilot conditioning plant (PKA), Gorleben

Site	Purpose	Capacity	Status
Gorleben	Design: Conditioning of spent fuel from power and research reactors; reloading of HLW glass canisters into packages suitable for disposal According to stipulation of 11 June 2001: Use restricted to the repair of defect containers	35 Mg HM/a at conditioning	Constructed, but not in operation. Licenced by 3rd Partial Licence (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 2010

Nuclear power plant *Land* (Federal State)	Applicant Date of application	Mass HM [Mg]	Activity [Bq]	Thermal power [MW]	Storage positions	Type Dimensions L x W x H wall/roof [m]	Container	Mass being stored (Containers)
Kernkraftwerk Biblis (KWB) Hesse	*RWE Power AG* 23 December 1999	1 400	$8.5x10^{19}$	5.3	135	WTI concept 92 x 38 x 18 0.85/0.55	CASTOR® V/19	468 Mg HM (46containers)
Kernkraftwerk Brokdorf (KBR) Schleswig-Holstein	*E.ON Kernkraft GmbH* 20 December 1999	1 000	$5.5x10^{19}$	3.75	100	STEAG concept 93 x 27 x 23 1.20/1.30	CASTOR® V/19	123 Mg HM (12 containers)
Kernkraftwerk Brunsbüttel (KKB) Schleswig-Holstein	*Kernkraftwerk Brunsbüttel GmbH* 30 November 1999	450	$6x10^{19}$	2.0	80	STEAG concept 88 x 27 x 23 1.20/1.30	CASTOR® V/52 (loading with 32 BE)	51 Mg HM (6 containers)
Kernkraftwerk Grafenrheinfeld (KKG) Bavaria	*E.ON Kernkraft GmbH* 23 February 2000	800	$5x10^{19}$	3.5	88	WTI concept 62 x 38 x 18 0.85/0.55	CASTOR® V/19	133 Mg HM (13 containers)
Kernkraftwerk Grohnde (KWG) Lower Saxony	*E.ON Kernkraft GmbH* 20 December 1999	1 000	$5.5x10^{19}$	3.75	100	STEAG concept 93 x 27 x 23 1.20/1.30	CASTOR® V/19	135 Mg HM (13 containers)
Kernkraftwerk Gundremmingen (KRB) Bavaria	*RWE Energie AG* (now: *RWE Power AG)* 25 February 2000	1 850	$2.4x10^{20}$	6.0	192	WTI concept 104 x 38 x 18 0.85/0.55	CASTOR® V/52	280 Mg HM (31containers)
Kernkraftwerk Isar (KKI) Bavaria	*E.ON Kernkraft GmbH* 23 February 2000	1 500	$1.5x10^{20}$	6.0	152	WTI concept 92 x 38 x 18 0.85/0.55	CASTOR® V/52 CASTOR® V/19	214 Mg HM (22 containers)
Kernkraftwerk Krümmel (KKK) Schleswig-Holstein	*Kernkraftwerk Krümmel GmbH* 30 November 1999	775	$0.96x10^{20}$	3.0	80	STEAG concept 83 x 27 x 23 1.20/1.30	CASTOR® V/52	175 Mg HM (19 containers)
Kernkraftwerk Emsland (KKE) Lower Saxony	*Kernkraftwerke Lippe-Ems GmbH* 22 December 1998	1 250	$6.9x10^{19}$	4.7	130	STEAG concept 110 x 30 x 20 1.20/1.30	CASTOR® V/19	327 Mg HM (32 containers)

Nuclear power plant *Land* (Federal State)	**Applicant Date of application**	**Mass HM [Mg]**	**Activity [Bq]**	**Thermal power [MW]**	**Storage positions**	**Type Dimensions L x W x H wall/roof [m]**	**Container**	**Mass being stored (Containers)**
Kernkraftwerk Neckarwestheim (GKN) Baden-Württem-berg	*Gemeinschaftskern-kraftwerk Neckar GmbH* 20 December 1999	1 600	$8.3x10^{19}$	3.5	151	2 tunnel tubes 112 and 82 x 12.8 x 17.3 respectively	CASTOR® V/19	333 Mg HM (36 containers)
Kernkraftwerk Philippsburg (KKP) Baden-Württem-berg	*EnBW Kraftwerke AG* 20 December 1999	1 600	$1.5x10^{20}$	6.0	152	WTI concept 92 x 37 x 18 0.70/0.55	CASTOR® V/19 CASTOR® V/52	357 Mg HM (36 containers)
Kernkraftwerk Unterweser (KKU) Lower Saxony	*E.ON Kernkraft GmbH* 20 December 1999	800	$4.4x10^{19}$	3.0	80	STEAG concept 80 x 27 x 23 1.20/1.30	CASTOR® V/19	72 Mg HM (7 containers)
Kernkraftwerk Obrigheim (KWO) Baden-Württem-berg	*Kernkraftwerk Obrigheim GmbH* 22 April 2005	100	$4.4x10^{18}$	0.3	15	Special hybrid solution 35 x 18 x 17 0.85/0.55	CASTOR® 440 mvK	- (Licence 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
	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
Eckert & Ziegler Nuclitec GmbH	Braunschweig	Drying facility	Drying of drums up to the specified residual humidity
		Compacting facility	Compaction of 200-l drums and scrunch drums, pressing power≥ 30 MPa Capacity: 5 000 – 10 000 pressing sequencies / a
		Decontamination cell	Decontamination of equipment parts (e.g. sandblasting); crushing of equipment parts (e.g. cutting, 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 m³ Capacity of second tub 5 m³
		Evaporation facility	Processing of radioactive liquid waste; Throughput 1 m³/h
		Rotary thin-film evaporation facility RDVA	Processing of radioactive liquid waste Throughput 200 to 250 l/h Reservoir 7 m³
		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 (blast area 8 m², height 2.5 m, blast medium steel grains or garnet sand), decontamination by means of hand-held blast pipe, treatment and re-use of the grit

Operator	Facility site	Facility name	Facility description
Wiederaufarbeitungsanlage Karlsruhe Rückbau- und Entsorgungs-GmbH Business unit: *Hauptabteilung Dekontaminationsbetriebe*	Karlsruhe	Compacting facility (MAW scrapping)	Compaction of non-heat-generating waste with high dose rate; Remote handling techniques with lock and working cells, manipulators, hydraulic shears, hydraulic press
		Compacting facility (LAW scrapping)	Compaction of non-heat-generating waste with low dose rate; caisson technique with gas protection suits; compaction with pre- and high-efficiency compactor; Max. throughput 3 000 m³/a; Volume reduction factor: 6
		Combustion facility	Combustion of solid and liquid waste
		Old evaporation and immobilisation facility (evaporation of LAW)	Evaporation of low-level radioactive waste water with subsequent cementation of the residues; Max. throughput 6 000 m³/a; Dismantling from 2012
		New evaporation facility for LAW	Evaporation of low-level radioactive waste water; Max. throughput 600 m³/a; Volume reduction factor: up to approx. 20
		Cementing facility	Cementation of residues from the “New evaporation facility for LAW”
		Equipment decontamination	Disassembling, conditioning and decontamination of solid, non-combustible residues; Throughput up to approx. 1 200 Mg/a
Wiederaufarbeitungsanlage Karlsruhe Rückbau- und Entsorgungs-GmbH Business unit*: Verglasung*	Karlsruhe	Vitrification plant	Vitrification of approx. 60 m³ high-level radioactive fission product concentrate from the operation of the WAK has been finished; post-operational phase
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

Operator	Facility site	Facility name	Facility description
Forschungszentrum Jülich GmbH (FZJ)	Jülich	Evaporation facility	Processing of low-active waste water, concentrates and sludges; total volume 825 m³, 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
GKSS *Forschungszentrum Geesthacht GmbH*	Geesthacht	Drying facility	Vacuum drying facility for single drums (200-l to 400-l drums)
Verein für Kernverfahrenstechnik 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 m³/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	Licence
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 StrlSchV
	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 StrlSchV
	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 StrlSchV
	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 StrlSchV
	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 StrlSchV
	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 StrlSchV
	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 StrlSchV
	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 StrlSchV
	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	Licence
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)
RWE NUKEM GmbH, Alzenau (Bavaria)	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-l, 400-l 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-l and 400-l 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-l, 400-l 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-Western Pomerania	Interim storage of operational and decommissioning waste from the nuclear power plants Greifswald and Rheinsberg, including interim storage of dismantled large components; Buffer storage of waste that will be conditioned for third party	200 000 m³	Handling licences according to § 3 StrlSchV*) of 20 February 1998	In operation since March 1998
Hauptabteilung Dekontaminationsbetriebe	1. Waste with negligible heat generation 2. Heat-generation waste including waste from some customers	1. 77 424 m³ (storage volume) 2. 1 240 m³ (storage volume)	Handling licence according to § 9AtG of 24 November 1983, superseded by licence according to § 9AtG of 29 June2009	In operation since December 1964

*) as amended on 13 October 1976 or 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 waste 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	
NPP Krümmel	Storage of radioactive waste from the operation of the NPP	1 340 m^3	§ 7 AtG	

Name of facility and site	Purpose of the facility	Capacity according to licence	Licence	Remarks
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	350 m^3	§ 7 AtG	

*) as amended on 20 July 2001

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

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 m³	§ 7 AtG	
NPP Stade	Storage of radioactive waste from the decommissioning of the NPP	4 000 m³	§ 7 StrlSchV	Commissioning: 1 August 2007
NPP Würgassen	Storage of radioactive waste from the decommissioning of the NPP	4 600 m^3	§ 7 AtG	

*) as amended on 13 October 1976, 30 June 1989 and 12 December 2007, respectively; the allocation areas are licenced in the decommissioning licence according to § 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 m³ available
Forschungszentrum Geesthacht	Operational waste from the research reactor	Not determined in the licence	§ 3 StrlSchV*)	Approx. 154 m² 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 StrlSchV*)	Approx. 8 140 m³ available
Institut für Radiochemie Garching	Operational waste from the research centre	Approx. 22 m³	§ 9 AtG, § 3 StrlSchV*)	
VKTA Rossendorf	Operational and decommissioning waste from the research institution	2 270 m³ (total gross storage volume)	§ 3 StrlSchV*)	*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 m³	§§ 6, 7 AtG,	
Siemens, Karlstein	Waste from dismantling	4 800 m³	§ 3 StrlSchV*)	
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 m³ 2. approx. 4 000 m³	§ 7 StrlSchV	
Urenco, Gronau	Operational waste from uranium enrichment	563.5 m³	§ 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 (for waste from research reactors, see Table L-10)

Name of facility and site	Kind of waste stored	Capacity according to licence	Licence	Remarks
Land collecting facility Baden-Württemberg, Karlsruhe	Waste from the medical field, research and industry	No capacity limit stated (capacity HDB: 78 664 m³)	§ 9 AtG	*Land* collecting facility at FZK in HDB, operator HDB
Land collecting facility Bavaria, Mitterteich	Waste from the medical field, research and industry	10 000 packages	§ 3 StrlSchV*)	Approx. 2 900 m³ available
Land collecting facility Berlin, Berlin	Waste from the medical field, research and industry	445 m³	§ 3 StrlSchV*)	At the *Helmholtz-Zentrum Berlin*
Land collecting facility Hesse, Ebsdorfergrund	Waste from the medical field, research and industry	400 m³	§ 6 AtG § 3 StrlSchV*)	
Land collecting facility Mecklenburg-Western Pomerania, Rubenow/Greifswald	Waste from the medical field, research and industry	one 20'-container	§ 3 StrlSchV*)	*Land* collecting facility at ZLN, approx. 33 m³ available joint use by Brandenburg
Land 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 Saxony *Land* collecting facility at Steyerberg
Land collecting facility North Rhine-Westphalia, Jülich	Waste from the medical field, research and industry	2 430 m³	§ 3 StrlSchV*), § 9 AtG	On the site of the *Forschungszentrum Jülich* (Jülich Research Centre)
Land collecting facility Rhineland-Palatinate, Ellweiler	Waste from the medical field, research and industry	500 m³	§ 9 AtG, § 3 StrlSchV*)	
Land collecting facility Saarland, Elm-Derlen	Waste from the medical field, research and industry	50 m³	§ 3 StrlSchV*)	
Land collecting facility Saxony, Rossendorf/Dresden	Waste from the medical field, research and industry	300 m³	§ 3 StrlSchV*)	At VKTA, also used by Thuringia and Saxony-Anhalt
Land collecting facility of the four north German coastal Federal State, Geesthacht	Waste from the medical field, research and industry	68 m² storage area	§ 3 StrlSchV*)	Shared use by Schleswig-Holstein, Hamburg and Bremen, the Lower Saxon contingent has been exhausted for several years already
Eckert & Ziegler Nuclitec GmbH, Braunschweig	Waste from the medical field, research and industry	3 240 m³	§ 3 StrlSchV*)	Waste from the closed Steyerberg site of the Lower Saxony *Land* 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, Lower Saxony	Disposal of low and intermediate level radioactive waste; research and development work for the disposal of radioactive and radiotoxic waste	Between 1967 and 1978 approx. 124 500 LAW waste packages, including approx. 15 000 so-called “Lost concrete shieldings” (VBA) with higher active waste, and approx. 1 300 MAW waste packages were emplaced for trial purposes. Total activity of the waste emplaced: 2.3×10^{15} Bq (as per 1 January 2010)	Licence according to § 3 StrlSchV in the version dated 15 October 1965 Handling licence according to § 7 StrlSchV and acquisition of facts according to § 9 AtG	Geological host formation: rock salt
BERGWERK ZUR ERKUNDUNG DES SALZSTOCKS GORLEBEN Gorleben, Lower Saxony	Evaluation 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
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 in the process of decommissioning including prototype reactors with electrical power generation as per 31 December2010

	Name of facility, location	**Last operator**	**Type of facility, electrical output (gross)**	**First criticality**	**Final shut-down**	**Status**	**Planned final status**
1	VAK *Verrsuchsatom-kraftwerk, Kahl*, Bavaria	*Versuchsatomkraftwerk Kahl GmbH*	BWR 16 MWe	11/1960	11/1985	Removed	-
2	MZFR *Mehrzweckforschungs-reaktor, Karlsruhe*, Baden-Württemberg	*WAK GmbH*	PWR with D_2O 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	Removal
4	KRB A Gundremmingen A, Gundremmingen, Bavaria	*Kernkraftwerk RWE-Bayernwerk GmbH*	BWR 250 MWe	08/1966	01/1977	Dismantling, conversion to waste man. centre	Waste manage-ment centre
5	AVR *Atomversuchskraftwerk, Jülich*, North Rhine-Westphalia	*AVR 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 enclosure	Removal, clearance of the site
7	KWO Obrigheim, Obrigheim, Baden-Württemberg	*EnBW Kernkraft GmbH - Kernkraftwerk Obrigheim*	PWR 357 MWe	09/1968	05/2005	Dismantling	Removal, clearance of the site
8	HDR *Heißdampfreaktor, Großwelzheim*, Bavaria	*Karlsruher Institut für Technologie*	HDR 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	Removal, clearance of the site
10	KKN Niederaichbach Niederaichbach, Bavaria	*Karlsruher Institut für Technologie*	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	Removal, 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	Removal
13	KGR 2 Greifswald 2 Lubmin, Mecklenburg-Western Pomerania	*Energiewerke Nord GmbH*	PWR (WWER) 440 MWe	12/1974	02/1990	Dismantling	Removal
14	KGR 3 Greifswald 3 Lubmin, Mecklenburg-Western Pomerania	*Energiewerke Nord GmbH*	PWR (WWER) 440 MWe	10/1977	02/1990	Dismantling	Removal
15	KNK II *Kompakte Natriumgekühlte Reaktoranlage, Karlsruhe*, Baden-Württemberg	*WAK GmbH*	SBR 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	Removal
17	THTR-300 *Thorium-Hochtempe-raturreaktor, 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	Clear-ance of the site
19	KGR 5 Greifswald 5 Lubmin, Mecklenburg-Western Pomerania	*Energiewerke Nord GmbH*	PWR (WWER) 440 MWe	03/1989	11/1989	Dismantling	Removal

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 critica-lity	Final shut-down	Status	Planned final status
1	FMRB – Braunschweig, Lower Saxony	*Physikalisch-Technische Bundesanstalt*	Pool 1 MW	10/1967	12/1995	Released from the scope of the AtG except the interim storage facility	-
2	FR-2 – Karlsruhe, Baden-Württemberg	*WAK GmbH*	Tank 44 MW	03/1961	12/1981	Reactor core in safe enclosure	Removal
3	FRG-1 – Geesthacht, Schleswig-Holstein	*Helmholtz-Zentrum Geesthacht GmbH*	Pool 5 MW	10/1958	06/2010	Shut-down, application for decom-missioning not yet filed	Removal
4	FRG-2 – Geesthacht, Schleswig-Holstein	*Helmholtz-Zentrum Geesthacht GmbH*	Pool 15 MW	03/1963	01/1993	Shut-down, partly dismantled	Removal
5	FRJ-1 MERLIN – Jülich, North Rhine-Westphalia	*Forschungszentrum Jülich GmbH*	Pool 10 MW	02/1962	03/1985	Removed	-
6	FRJ-2 DIDO – Jülich, North Rhine-Westphalia	*Forschungszentrum Jülich GmbH*	DIDO 23 MW	11/1962	05/2006	Shut-down, decom-missioning applied for	Removal
7	FRM – München, Bavaria	*Technische Universität München*	Pool 4 MW	10/1957	07/2000	Shut-down, fuel assemblies removed, de-commissioning applied for	Partial dis-mantling, conversion to attendant facility of FRM II
8	FRN – Neuherberg, Bavaria	*Helmholtz Zentrum München GmbH*	TRIGA 1 MW	08/1972	12/1982	Safe enclosure	Not yet decided
9	*Nuklearschiff Otto Hahn*, Geesthacht, Schleswig-Holstein	*Helmholtz-Zentrum Geesthacht GmbH*	PWR, ship propulsion 38 MW	08/1968	03/1979	Ship's reactor dismantled and stored	Removal
10	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

	Name of facility, location	Last operator	Type, thermal output	First critica-lity	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	*Helmholtz-Zentrum 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. (FRF-2 in the same building never been critical)	*Johann-Wolfgang-Goethe-Universität Frankfurt/M.*	Homog. reactor 50 kW	01/1958	03/1968	Removed	-
7	FRH – Hanover, Lower Saxony	*Medizinische Hochschule Hannover*	TRIGA 250 kW	01/1973	12/1996	Removed	-
8	HD I – Heidelberg, Baden-Württemberg	*Deutsches Krebsforschungs-zentrum Heidelberg*	TRIGA 250 kW	08/1966	03/1977	Removed	-
9	HD II – Heidelberg, Baden-Württemberg	*Deutsches Krebsforschungs-zentrum 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	-

	Name of facility, location	Last operator	Type, thermal output	First critica-lity	Final shut-down	Status	Planned final status
16	SNEAK, Karlsruhe, Baden-Württemberg	*Kernforschungs-zentrum Karlsruhe*	Homog. reactor 1 kW	12/1966	11/1985	Removed	-
17	STARK, Karlsruhe, Baden-Württemberg	*Kernforschungs-zentrum Karlsruhe*	Argonaut 0.01 kW	01/1963	03/1976	Removed	-
18	SUR Berlin – Berlin	*Technische Hochschule Berlin*	Homog. reactor < 1 W	07/1963	10/2007	Dis-mantling	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. Reaktor < 1 W	01/1965	08/1992	Removed	-
22	SUR Karlsruhe – Karlsruhe, Baden-Württemberg	*Karlsruher Inst. für Technologie*	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	*Kernforschungs-zentrum Karlsruhe*	Fast subcrit. formation < 1 W	11/1964	12/1978	Removed	-
26	SUA München – Munich, Bavaria	*Technische Universität München*	Subcritical formation < 1 W	06/1959	10/1968	Removed	-
27	ZLFR – Zittau, Saxony	*Hochschule Zittau/Görlitz*	10 W	05/1979	03/2005	Removed	-
28	SUR Aachen – Aachen, North Rhine-Westphalia	*RWTH Aachen*	Homog. reactor < 1 W	09/1965	2008	Decommis sioning applied for	Removal
29	SUR Hannover – Hanover, Lower Saxony	*Leibniz-Universität Hannover*	Homog. reactor < 1 W	12/1971	2000	Decommis sioning planned	Removal

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*	1973	1988	Removed	-
2	NUKEM-A *Brennelementwerk– Hanau*, Hesse	*Nukem GmbH*	1962	1988	Removed, groundwater remediation	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	*Wiederaufarbeitung sanlage Karlsruhe Rückbau- und Entsorgungs-GmbH*	1971	1990	Dismantling	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	*Karlsruher Institut für Technologie*	1970	1991	Removed	-
3	PUTE *Plutoniumextraktionsanlage – Karlsruhe*, Baden-Württemberg	*Karlsruher Institut für Technologie*	1980	1991	Removed	-

(d) 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 licencing 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 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 (BMU) 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] Grundgesetz für die Bundesrepublik Deutschland vom 23. Mai 1949 (BGBl. I 1949, Nr. 1, S. 1), geändert bzgl. Kernenergie durch Gesetz vom 23. Dezember 1959, betreffend Artikel 74a Nr. 11 und 87c (BGBl. I 1959, Nr. 56, 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)
Hinweis: Verlagerung des Gebietes Kernenergie in die ausschließliche Gesetzgebungskompetenz des Bundes

[1A-2] Gesetz zur geordneten Beendigung der Kernenergienutzung zur gewerblichen Erzeugung von Elektrizität vom 22. April 2002 (BGBl. I S. 1351)

[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 1985, Nr. 41, S. 1565), zuletzt geändert durch Artikel 1 des Gesetzes vom 31. Juli 2011 (BGBl.I 2011, Nr. 43, S. 1704)
Hinweis: Geändert durch Artikel 1 des Gesetzes vom 29. August 2008 (BGBl.I 2008, Nr. 40, S. 1793), diese Änderung tritt erst in Kraft, wenn das Protokoll vom 12. Februar 2004 zur Änderung des Übereinkommens vom 29. Juli 1960 über die Haftung gegenüber Dritten auf dem Gebiet der Kernenergie in der Fassung des Zusatzprotokolls vom 28. Januar 1964 und des Protokolls vom 16. November 1982 nach seinem Artikel 20 in Kraft tritt

[1A-4] 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 1990, Nr. 35, S. 885 und 1226), soweit dabei radioaktive Stoffe, insbesondere Radonfolgeprodukte, anwesend sind:

- Verordnung über die Gewährleistung von Atomsicherheit und Strahlenschutz - AtStrlSV - vom 11. Oktober 1984 (GBl. (DDR) I 1984, Nr. 30, S. 341) und Durchführungsbestimmung zur Verordnung über die Gewährleistung von Atomsicherheit und Strahlenschutz - AtStrlSVDBest - vom 11. Oktober 1984 (GBl. (DDR) I 1984, Nr. 30, S. 348, 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 - StrSAblAnO - vom 17. November 1980 (GBl. (DDR) I 1980, Nr. 34, S. 347)

[1A-5] Gesetz zum vorsorgenden Schutz der Bevölkerung gegen Strahlenbelastung (Strahlenschutzvorsorgegesetz - StrVG) vom 19. Dezember 1986 (BGBl. I, Nr. 69, S. 2610), zuletzt geändert durch Artikel 1 des Gesetzes vom 8. April 2008 (BGBl. I 2008, Nr. 14, S. 686)

[1A-6] Gesetz über die Errichtung eines Bundesamtes für Strahlenschutz - BAStrlSchG - vom 9. Oktober 1989 (BGBl. I, Nr. 47, S. 1830), zuletzt geändert durch Artikel 2 des Gesetzes vom 3. Mai 2000 (BGBl. I 2000, Nr. 20, S. 636)

[1A-8] Verordnung über den Schutz vor Schäden durch ionisierende Strahlen (Strahlenschutzverordnung - StrlSchV) vom 20. Juli 2001 (BGBl. I 2001, Nr. 38, S. 1714), zuletzt geändert durch Artikel 3 des Gesetzes vom 13. Dezember 2007 (BGBl. I 2007, Nr. 65, S. 2930), in Überarbeitung, Dosiskoeffizienten in BAnz 2001, Nr. 16
Hinweis: geändert durch Artikel 2 des Gesetzes vom 29. August 2008 (BGBl.I 2008, Nr. 40, S. 1793), diese Änderung tritt erst in Kraft, wenn das Protokoll vom 12. Februar 2004 zur Änderung des Übereinkommens vom 29. Juli 1960 über die Haftung gegenüber Dritten auf dem Gebiet der Kernenergie in der Fassung des Zusatzprotokolls vom 28. Januar 1964 und des Protokolls vom 16. November 1982 nach seinem Artikel 20 in Kraft tritt

[1A-10] 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, S. 180), zuletzt geändert durch Artikel 4 des Gesetzes vom 9. Dezember 2006 (BGBl. I 2006, Nr. 58, S. 2819)

[1A-11] Verordnung über die Deckungsvorsorge nach dem Atomgesetz (Atomrechtliche Deckungsvorsorge-Verordnung - AtDeckV) vom 25. Januar 1977 (BGBl. I 1977, Nr. 8, S. 220), zuletzt geändert durch Artikel 9 Abs. 12 des Gesetzes vom 23. November 2007 (BGBl. I 2007, Nr. 59, S. 2631)

[1A-12] Kostenverordnung zum Atomgesetz - AtKostV - vom 17. Dezember 1981 (BGBl. I, Nr. 56, S. 1457), zuletzt geändert durch Artikel 4 des Gesetzes vom 29. August 2008 (BGBl. I 2008, Nr. 40, S. 1793)

[1A-13] Verordnung über Vorausleistungen für die Einrichtung von Anlagen des Bundes zur Sicherstellung und zur Endlagerung radioaktiver Abfälle (Endlagervorausleistungsverordnung - EndlagerVlV) vom 28. April 1982 (BGBl. I, Nr. 16, S. 562), zuletzt geändert durch VO vom 6. Juli 2004 (BGBl. I 2004, Nr. 33, S. 1476)

[1A-14] Verordnung zur Errichtung eines Strahlenschutzregisters vom 3. April 1990 (BGBl. I, S. 607)

[1A-17] 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, S. 1766), zuletzt geändert durch VO vom 8. Juni 2010

(BGBl. I 2010, Nr. 31, S. 755)

[1A-18] Verordnung über die Verbringung radioaktiver Abfälle in das oder aus dem Bundesgebiet (Atomrechtliche Abfallverbringungsverordnung - AtAV) vom 30. April 2009 (BGBl. I 2009, Nr. 24, S. 1000)

[1A-19] Verordnung für die Überprüfung der Zuverlässigkeit zum Schutz gegen Entwendung oder Freisetzung radioaktiver Stoffe nach dem Atomgesetz (Atomrechtliche Zuverlässigkeitsüberprüfungs-Verordnung - AtZüV) vom 1. Juli 1999 (BGBl. I 1999, Nr. 35, S. 1525), zuletzt geändert durch Artikel 1 der VO vom 22. Juni 2010 (BGBl. I 2010, Nr. 34, S. 825)

[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, S. 850), zuletzt geändert durch Artikel 17 des Gesetzes vom 21. Juni 2005 (BGBl. I 2005, Nr. 39, S. 1793)

[1A-21] Gesetz zu dem 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 vom 12. Dezember 1991 (BGBl. II 1991, Nr. 31, S. 1138), zuletzt geändert durch Artikel 13 des Gesetzes vom 31. Oktober 2006 (BGBl. I 2006, Nr. 50, S. 2407)

[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 - Gorleben VSpV) vom 25. Juli 2005 (BAnz. Nr. 153a vom 16. August 2005)

[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)

1B Regulations concerning the safety of nuclear installations

[1B-1] Strafgesetzbuch – StGB - vom 15. Mai 1871 (RGBl. S. 127), Neufassung vom 13. November 1998 (BGBl. I 1998, Nr. 75, S. 3322), zuletzt geändert durch Artikel 4 des Gesetzes vom 23. Juni 2011 (BGBl.I 2011, Nr. 33, S. 1266)

[1B-2] Raumordnungsgesetz – ROG - vom 18. August 1997 (BGBl. I 1997, Nr. 59, S. 2081), Neufassung durch Gesetz vom 22. Dezember 2008 (BGBl.I 2008, Nr. 65, S. 2986), zuletzt geändert durch Artikel 9 des Gesetzes vom 31. Juli 2009 (BGBl.I 2009, Nr. 51, S. 2585)

[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 7 des Gesetzes vom 20. Juli 2011 (BGBl.I 2011, Nr. 39, S. 1474)

[1B-5] Wasserhaushaltsgesetz - WHG - vom 31. Juli 2009 (BGBl. I 2009, Nr. 51, S. 2585), geändert durch Artikel 12 des Gesetzes vom 11. August 2010 (BGBl. I 2010, Nr. 43, S. 1163)
Hinweis: Abweichendes Landesrecht: Bayerisches Wassergesetz (BayWG, gültig bis 29. Februar 2012) (BGBl. I 2010, Nr. 11, S. 275); Niedersächsisches Wassergesetz (BGBl. I 2010, Nr. 38, S. 970); Schleswig-Holsteinisches Wassergesetz (BGBl. I 2010, Nr. 55, S. 1501); Wassergesetz des Landes Sachsen-Anhalt (BGBl. I 2011, Nr. 15, S. 567); Hessisches Wassergesetz (BGBl. I 2011, Nr. 16, S. 607); Sächsisches Wassergesetz (BGBl. I 2011, Nr. 22, S. 842); Bremisches Wassergesetz (BGBl. I 2011, Nr. 26, S. 1010 und Nr. 27, S. 1035)

[1B-6] Gesetz über Naturschutz und Landschaftspflege (Bundesnaturschutzgesetz - BNatSchG) vom 29. Juli 2009 (BGBl.I 2009, Nr. 51, S. 2542)
Hinweis: Abweichendes Landesrecht: Bayerisches Naturschutzgesetz (BayNatSchG) (BGBl.I 2010, Nr. 11, S. 275); Landesnaturschutzgesetz (LNatSchG) Schleswig-Holstein (BGBl. I 2010, Nr. 17, S. 450); Niedersächsisches Ausführungsgesetz zum Bundesnaturschutzgesetz (BGBl. I 2010, Nr. 38, S. 970), Naturschutzausführungsgesetz von Mecklenburg-Vorpommern (BGBl. I 2010, Nr. 58, S. 1621); Naturschutzgesetz des Landes Sachsen-Anhalt (BGBl. I 2011, Nr. 1, S. 30); Hamburgisches Gesetz zur Ausführung des Bundesnaturschutzgesetzes (BGBl. I 2011, Nr. 4, S. 93); Hessisches Ausführungsgesetz zum Bundesnaturschutzgesetz (BGBl. I 2011, Nr. 18, S. 663); Sächsisches Naturschutzgesetz (BGBl. I 2011, Nr. 22, S. 842)

[1B-7] Gesetz über technische Arbeitsmittel und Verbraucherprodukte (Geräte- und Produktsicherheitsgesetz - GPSG) vom 6. Januar 2004 (BGBl. I 2004, Nr. 1, S. 2), zuletzt geändert durch Artikel 2 des Gesetzes vom 7. März 2011 (BGBl. I 2011, Nr. 9, S. 338)

- 6. GPSGV über das Inverkehrbringen von einfachen Druckbehältern vom 25. Juni 1992 (BGBl. I 1992, Nr. 29, S. 1171), zuletzt geändert durch Artikel 6 Absatz 3 der Verordnung vom 6. März 2007 (BGBl. I 2007, Nr. 8, S. 261)
  Hinweis: „Geräte, die speziell zur Verwendung in der Kerntechnik hergestellt sind und bei denen Schäden zu einer Freisetzung von Radioaktivität führen können“ sind hier ausgenommen
- 8. GPSGV über das Inverkehrbringen von persönlichen Schutzausrüstungen vom 10. Juni 1992, Neufassung vom 20. Februar 1997 (BGBl.I, Nr. 11, S. 316), geändert durch Artikel 15 des Gesetzes vom 6. Januar 2004 (BGBl. I 2004, Nr. 1, S. 2)
- 9. GPSGV- Maschinenverordnung vom 12. Mai 1993 (BGBl. I 1993, Nr. 22, S. 704), zuletzt geändert durch Artikel 1 der Verordnung vom 18. Juni 2008 (BGBl. I 2008, Nr. 25, S. 1060)
  Hinweis:„Maschinen, die speziell zur nuklearen Verwendung entwickelt und eingesetzt werden und deren Ausfall zu einer Freisetzung von Radioaktivität führen kann“ sind hier ausgenommen
- 14. GPSGV- Druckgeräteverordnung vom 27. September 2002 (BGBl.I 2002, Nr. 70, S. 3777), zuletzt geändert durch Artikel 21 des Gesetzes vom 6. Januar 2004 (BGBl. I 2004, Nr. 1, S. 2)
  Hinweis: „Geräte, die speziell zur Verwendung in kerntechnischen Anlagen entwickelt wurden und deren Ausfall zu einer Freisetzung von Radioaktivität führen kann“ sind hier ausgenommen

[1B-8] Verordnung über Sicherheit und Gesundheitsschutz bei der Bereitstellung von Arbeitsmitteln und deren Benutzung bei der Arbeit, über Sicherheit beim Betrieb überwachungsbedürftiger Anlagen und über die Organisation des betrieblichen Arbeitsschutzes (Betriebssicherheitsverordnung – BetrSichV) vom 27. September 2002 (BGBl. I 2002, Nr. 70, S. 3777), zuletzt geändert durch Artikel 5 Absatz 7 der Verordnung vom 26. November 2010 (BGBl. I 2010, Nr. 59, S. 1643)
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 - AsiG - vom 12. Dezember 1973 (BGBl. I 1973, Nr. 105, S. 1885), zuletzt geändert durch Artikel 226 der Verordnung vom 31. Oktober 2006 (BGBl. I 2006, Nr. 50, S. 2407)

[1B-13] Kreislaufwirtschafts- und Abfallgesetz - KrW-/AbfG - vom 27. August 1994 (BGBl.I 1994, Nr. 66, S. 2705), zuletzt geändert durch Artikel 8 des Gesetzes vom 11. August 2010 (BGBl. I 2010, Nr. 43, S. 1163)

[1B-14] Umweltverträglichkeitsprüfungsgesetz - UVPG - vom 12. Februar 1990 (BGBl. I 1990, Nr. 6, S. 205), Neufassung vom 24. Februar 2010 (BGBl. I 2010, Nr. 7, S. 94), zuletzt geändert durch Artikel 4 des Gesetzes vom 26. Juli 2011 (BGBl.I 2011, Nr. 41, S. 1554)
Hinweis: Abweichendes Landesrecht: Niedersächsisches Gesetz über die Umweltverträglichkeitsprüfung (BGBl. I 2010, Nr. 38, S. 970), Landesgesetz über die Umweltverträglichkeitsprüfung (Landes-UVP-Gesetz - LUVPG) von Schleswig-Holstein (BGBl. I 2011, Nr. 6, S. 244)

[1B-15] Bundesberggesetz - BBergG - vom 13. August 1980 (BGBl. I, Nr. 48, S. 1310), zuletzt geändert Artikel 15a des Gesetzes vom 31. Juli 2009 (BGBl. I 2009, Nr. 51, S. 2585)

[1B-16] Umweltinformationsgesetz - UIG - 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), Neufassung durch Artikel 1 der Verordnung vom 26. November 2010 (BGBl. I 2010, Nr. 59, S. 1643), geändert durch Artikel 2 des Gesetzes vom 28. Juli 2011 (BGBl. I 2011, Nr. 41, S. 1622)

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)
Hinweis: Auf diese Quelle greifen die internationalen und nationalen Vorschriften zurück, die einzelnen Staaten haben sich verpflichtet, diese Regelungen umzusetzen

[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
Gesetz dazu - ADRG - vom 18. August 1969 (BGBl. II 1969, S. 1489), zuletzt geändert durch Artikel 239 der Verordnung vom 31. Oktober 2006 (BGBl.I 2006, Nr. 50, S. 2407),
mit bislang 21 Änderungsverordnungen - ADRÄndV -
21. ADRÄndV vom 7. Oktober 2010 (BGBl. II 2010, Nr. 28, S. 1134)
Neufassung der Anlagen A und B zum ADR vom 25. November 2010 (BGBl. II 2010, Nr. 34, S. 1412; Anlagenband)
Hinweis: Weiterführende Informationen finden Sie auf der Internetseite des Bundesministeriums für Verkehr, Bau und Stadtentwicklung

[1C-4] Übereinkommen vom 9. Mai 1980 über den internationalen Eisenbahnverkehr COTIF, (BGBl. II 1985, Nr. 5, S. 132)
Gesetz dazu vom 23. Januar 1985 (BGBl. II 1985, Nr. 5, S. 130), Neufassung gemäß Artikel 1 des Protokolls vom 3. Juni 1999 (BGBl. II 2002, Nr. 33, S. 2140), Erste Verordnung zur Änderung des Übereinkommens COTIF in der Fassung des Änderungsprotokolls vom 3. Juni 1999 vom 4. November 2010 (BGBl. II, Nr. 32, S. 1246), Änderungsprotokoll vom 3. Juni 1999 ist in Kraft seit 1. Dezember 2010 (BGBl. II 2011, Nr. 6, S. 231)

- Anhang A: Einheitliche Rechtsvorschriften für den Vertrag über die internationale Eisenbahnbeförderung von Personen - CIV (BGBl.II 2002, Nr. 33, S. 2190)
- Anhang B: Einheitliche Rechtsvorschriften für den Vertrag über die internationale Eisenbahnbeförderung von Gütern - CIM (BGBl. II 2002, Nr. 33, S. 2221)
- Anlage C: Ordnung für die internationale Eisenbahnbeförderung gefährlicher Güter - RID (BGBl.II 1999, Nr. 33, S. 2256), Neufassung vom 16. Mai 2008 (BGBl. II 2008, Nr. 12, S. 475 mit Anlagenband), Fehlerverzeichnis 2 vom 18. August 2008 (BGBl. II 2008, Nr. 23, S. 899), geändert durch die 14. RID-Änderungsverordnung vom 14. November 2008 (BGBl. II 2008, Nr. 33, S. 1334), Fehlerverzeichnisse 1 und 2 zur Neufassung der RID 2007 und zu der 14. RID-Änderungsverordnung vom 29. Oktober 2009 (BGBl. II, Nr. 35, S. 1188), geändert durch 15. RID-Änderungsverordnung vom 22. Dezember 2009 (BGBl. II 2009, Nr. 40, S. 1290), Änderung durch 16. RID-Änderungsverordnung vom 11. November 2010 (BGBl. II 2010, Nr. 32, S. 1273)

Hinweis: Grundlage ist die IAEA-Empfehlung

[1C-5] Internationale Vorschriften über die Beförderung gefährlicher Güter im Seeverkehr (International Maritime Dangerous Goods Code - IMDG-Code) der International Maritime Organisation (IMO), einer Sonderorganisation der UN, Bekanntmachung des IMDG-Code in der Fassung des Amendment 34-10 vom 10. November 2010 (VkBl. 2010, Nr. 22, S. 554, die deutschen Versionen werden als Download vom Ministerium für Verkehr, Bau und Stadtentwicklung bereitgestellt
Hinweis: Grundlage ist die IAEA-Empfehlung

[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 (VkBl. 2005, Nr. 6, S. 176) und am 4. März 2006 (VkBl. 2006, Nr. 11, S. 486), Änderung vom 20. Januar 2009 (VkBl. 2009, Nr. 3, S. 82)

[1C-16] Gesetz über die Beförderung gefährlicher Güter (Gefahrgutbeförderungsgesetz - GGBefG) vom 6. August 1975 (BGBl. I 1975, Nr. 95, S. 2121), Neufassung vom 7. Juli 2009 (BGBl. I 2009, Nr. 40, S. 1774), berichtigt am 28. Dezember 2009 (BGBl. I 2009, Nr, 81, S. 3975)

[1C-17] Verordnung über die innerstaatliche und grenzüberschreitende Beförderung gefährlicher Güter auf der Straße, mit Eisenbahnen und auf Binnengewässern (Gefahrgutverordnung Straße, Eisenbahn und Binnenschifffahrt - GGVSEB) vom 17. Juni 2009 (BGBl. I 2009, Nr. 33, S. 1389), zuletzt geändert durch Artikel 1 der Verordnung vom 4. März 2011 (BGBl. I 2011, Nr. 9, S. 347)
Hinweis: Ersetzt die GefahrgutVO Straße und Eisenbahn

- Erste Bekanntmachung zur GGVSEB vom 26. November 2010 (VkBl. 2010, Nr. 24, S. 650)

[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 22. Februar 2010 (BGBl. I 2010, Nr. 10, S. 238), geändert durch Artikel 2 der Verordnung vom 3. August 2010 (BGBl. I 2010, Nr. 42, S. 1139)

[1C-19] Luftverkehrsgesetz - LuftVG - vom 1. August 1922 (RGBl. I 1922, S. 681), Neufassung vom 10. Mai 2007 (BGBl. I 2007, Nr. 20, S. 698), zuletzt geändert durch Artikel 1 des Gesetzes vom 5. August 2010 (BGBl. I 2010, Nr. 41, S. 1126)

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, S. 206); in Kraft seit 1. Oktober 1992 (BGBl. II 1992, S. 593)

[1D-2] Abkommen zwischen der Bundesrepublik Deutschland und dem Königreich Belgien über die gegenseitige Hilfeleistung bei Katastrophen oder schweren 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)

[1D-3]). Abkommen zwischen der Bundesrepublik Deutschland und der Schweizerischen Eidgenossenschaft über die gegenseitige Hilfeleistung bei Katastrophen oder schweren 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)

[1D-4] Abkommen zwischen der Bundesrepublik Deutschland und dem Königreich Dänemark über die gegenseitige Hilfeleistung bei Katastrophen oder schweren 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)

[1D-5] Abkommen zwischen der Bundesrepublik Deutschland und der Französischen Republik über die gegenseitige Hilfeleistung bei Katastrophen oder schweren 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)

[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, S. 1189); in Kraft seit 11. September 1998 (BGBl. II 1999, S: 125)

[1D-7] Abkommen zwischen der Bundesrepublik Deutschland und der Republik Litauen über die gegenseitige Hilfeleistung bei Katastrophen oder schweren Unglücksfällen vom 15. März 1994; Gesetz dazu vom 12. Januar 1996 (BGBl. II 1996, S. 27); in Kraft seit 1. September 1996 (BGBl. II 1996, S. 1476)

[1D-8] Abkommen zwischen der Bundesrepublik Deutschland und dem Großherzogtum Luxemburg über die gegenseitige Hilfeleistung bei Katastrophen oder schweren Unglücksfällen vom 2. März 1978; Gesetz dazu vom 7. Juli 1981 (BGBl. II 1981, S. 445); in Kraft seit 1. Dezember 1981 (BGBl. II 1981, S. 1067)

[1D-9] Abkommen zwischen der Bundesrepublik Deutschland und dem Königreich der Niederlande über die gegenseitige Hilfeleistung bei Katastrophen einschließlich schweren Unglücksfällen vom 7. Juni 1988; Gesetz dazu vom 20. März 1992 (BGBl. II 1992, S. 198); in Kraft seit 1. März 1997 (BGBl. II 1997, S. 753 und S. 1392)

[1D-10] Abkommen zwischen der Bundesrepublik Deutschland und der Republik Polen über die gegenseitige Hilfeleistung bei Katastrophen oder schweren Unglücksfällen vom 10. April 1997; Gesetz dazu vom 7. Juli 1998 (BGBl. II 1998, S. 1178); in Kraft seit 1. März 1999 (BGBl. II 1999, S. 15)

[1D-11] Abkommen zwischen der Bundesrepublik Deutschland und der Russischen Föderation über die gegenseitige Hilfeleistung bei Katastrophen oder schweren Unglücksfällen vom 16. Dezember 1992; Gesetz dazu vom 19. Oktober 1994 (BGBl. II 1994, S. 3542); in Kraft seit 11. Juli 1995 (BGBl. II 1997, S. 728)

[1D-12] Vertrag zwischen der Bundesrepublik Deutschland und der Tschechischen Republik über die gegenseitige Hilfeleistung bei Katastrophen und schweren 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)

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 the Environmental Impact Assessment in a Transboundary Context - EIA) vom 25. Februar 1991, in Kraft seit 10. September 1997
45 Vertragsparteien (08/11), Depositar: UN
1. Änderung der Espoo-Konvention vom 27. Februar 2001, noch nicht in Kraft
21 Vertragsparteien (08/11), Depositar: UN
2. Änderung der Espoo-Konvention vom 4. Juni 2004, noch nicht in Kraft, zwischen Deutschland, Österreich, Schweiz und Lichtenstein abgestimmte deutsche Übersetzung
17 Vertragsparteien (08/11), Depositar: UN
Gesetz zur Espoo-Konvention und der 1. Änderung mit amtlicher Übersetzung (Espoo-Vertragsgesetz) vom 7. Juni 2002 (BGBl. II 2002, Nr. 22, S. 1406)
Espoo-Konvention in Kraft für Deutschland seit 6. November 2002
Gesetz zur 2. Änderung mit amtlicher Übersetzung (Zweites 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; zwischen Deutschland, Österreich und Schweiz abgestimmte deutsche Fassung in Kraft für Deutschland seit 15. Januar 2007 (BGBl. II 2007, Nr. 27, S. 1392)
44 Vertragsparteien (08/11), Depositar: UNECE
Gesetz dazu (Informationsfreiheitsgesetz) vom 5. September 2005 (BGBl. I 2005, Nr. 57, S. 2722)
Gesetz dazu mit amtlicher Übersetzung (Vertragsgesetz) vom 9. Dezember 2006 (BGBl. II 2006, Nr. 31, S. 1251)
Aarhus-Übereinkommen in Kraft für Deutschland seit 15. April 2007 (BGBl. II 2007, Nr. 27, S. 1392)
Protokoll zu Registern über die Freisetzung und Verbringung von Schadstoffen zur Aarhus-Konvention (Protocol on Pollutant Release and Transfer Registers to the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters - PRTR) vom 21. Mai 2003, in Kraft seit 8. Oktober 2009
27 Vertragsparteien (08/11), Depositar: UN
Ergänzung zur Aarhus-Konvention (Amendment to the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters) vom 27. Mai 2005 (betrifft GMO - genetically modified organisms), noch nicht in Kraft
26 Vertragsparteien (02/11), Depositar: UN
Gesetz dazu (Erstes Aarhus-Änderungs-Übereinkommen) mit amtlicher Übersetzung vom 17. Juli 2009 (BGBl. II 2009, Nr. 25, S. 794)

[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
48 Vertragsparteien (08/11), Depositar: ILO
Gesetz hierzu vom 23. Juli 1973 (BGBl. II 1973, Nr. 37, S. 933)
in Kraft für Deutschland seit 26. September 1974 (BGBl. II 1973, Nr. 63, S. 1593)

[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, Nr. 36, S. 857)
in Kraft für Deutschland seit 3. Juni 1965 (BGBl. II 1965, Nr. 46, S. 1579)
Neufassung vom 25. April 1968 (BGBl. II 1970, Nr. 20, S. 208), s. auch EURATOM-Grundnormen;
wurden 1981 ersetzt durch "Basic Safety Standards for Radiation Protection"

[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,
145 Vertragsparteien (09/10), Depositar: IAEA
Gesetz hierzu vom 24. April 1990 (BGBl. II 1990, Nr. 15, 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
48 Vertragsparteien (06/11), Depositar: OECD
Gesetz dazu vom 26. Mai 1959 (BGBl. II 1959, Nr. 23, S. 585),
in Kraft für Deutschland seit 22. Juli 1959 (BGBl. II 1959, Nr. 39, S. 989)

- Verfahrensordnung des Europäischen Kernenergie-Gerichts vom 11. Dezember 1962 (BGBl.II 1965, Nr. 38, S. 1334)

Hinweis: Das Übereinkommen gilt nach Artikel 1 lediglich für den Betrieb von Gemeinschaftsunternehmen im Rahmen der Kernenergieagentur der OECD. Es soll verhindern, dass diese Anlagen und Materialien militärischen Zwecken dienen. Dem nach Artikel 12 des Übereinkommens errichteten Europäischen Kernenergie-Gericht ist mit Artikel 17 des Pariser Atomhaftungs-Übereinkommens die Zuständigkeit zur Entscheidung von Streitigkeiten über die Auslegung des Pariser Atomhaftungs-Übereinkommens zugewiesen worden.

[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
Benachrichtigungsabkommen: 110 Vertragsparteien (05/11), Depositar: IAEA
Hilfeleistungsabkommen: 105 Vertragsparteien (05/10), Depositar: IAEA
Gesetz zu den beiden IAEA-Übereinkommen vom 16. Mai 1989 (BGBl. II 1989, Nr. 18, S. 434),
beide Übereinkommen in Kraft für Deutschland seit 15. Oktober 1989 (BGBl. II 1993, Nr. 34, S. 1830 und 1845)

[1E-7] Übereinkommen über nukleare Sicherheit (Convention on Nuclear Safety - CNS, (INFCIRC/449) vom 17. Juni 1994, in Kraft seit 24. Oktober 1996
74 Vertragsparteien (06/11), Depositar: IAEA
Gesetz dazu mit amtlicher Übersetzung 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;
60 Vertragsparteien (06/11), Depositar: IAEA
Gesetz hierzu mit amtlicher Übersetzung 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 - NPT, INFCIRC/140) vom 1. Juli 1968, in Kraft seit 5. März 1970
190 Vertragsparteien (08/11), Depositare: Russische Föderation, UK, USA
Gesetz dazu vom 4. Juni 1974 (BGBl. II 1974, Nr. 32, S. 785)
in Kraft für Deutschland seit 2. Mai 1975 (BGBl. II 1976, Nr. 25, S. 552)
Verlängerung des Vertrages auf unbegrenzte Zeit am 11. Mai 1995 (BGBl. II 1995, Nr. 34, 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.8) vom 5. April 1973, in Kraft für alle Vertragsparteien seit 21. Februar 1977, später ergänzt
Gesetz hierzu mit amtlicher Übersetzung vom 4. Juni 1974 (BGBl. II 1974, Nr. 32, S. 794)
Zusatzprotokoll vom 22. September 1998, in Kraft für Deutschland seit dem 30. April 2004
Gesetz zu dem Zusatzprotokoll mit amtlicher Übersetzung vom 29. Januar 2000 (BGBl. I 2000, Nr. 4, S. 70)
Ausführungsgesetz zum Verifikationsabkommen und zum Zusatzprotokoll vom 29. Januar 2000 (BGBl. I 2000, Nr. 5, S. 74)
Hinweis: Alle 13 Nichtkernwaffenstaaten der EURATOM (der EU15) haben die innerstaatliche Umsetzung vollzogen. Durch das Zusatzprotokoll werden die Kontrollbefugnisse der IAEO deutlich erweitert.

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 LDC (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, mit seither 5 Änderungen
87 Vertragsparteien (07/11)
Gesetz hierzu vom 11. Februar 1977 (BGBl. II 1977, Nr. 8, S. 165), zuletzt geändert durch Gesetz vom 25. August 1998 (BGBl. I, Nr. 57, S. 2455)
in Kraft für Deutschland seit 8. Dezember 1977 (BGBl. II 1979, Nr. 13, S. 273)
Protokoll LCProt1996 (IMO) vom 7. November 1996 zu diesem Übereinkommen (ersetzt die ursprüngliche Konvention), in Kraft seit 24. März 2006, Änderung vom 2. November 2006, diese in Kraft seit 10. Februar 2007
40 Vertragsparteien (07/11) Depositare: Mexiko, Russische Förderation, UK, USA
Gesetz dazu vom 9. Juli 1998 (BGBl. II 1998, Nr. 25, S. 1345), zuletzt geändert durch Verordnung vom 24. August 2010 (BGBl. II 2010, Nr. 24, S. 1006)
Protokoll LCProt1996 in Kraft für Deutschland seit 24. März 2006 (BGBl. II 2010, Nr. 35, S. 1429)
Hinweis: Keine Einbringung von Materialien mit Radioaktivitätswerten oberhalb de-minimis-Konzentrationen

Liability

[1E-11] Übereinkommen über die Haftung gegenüber Dritten auf dem Gebiet der Kernenergie - Pariser 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 in Kraft seit 1. April 1968,
ergänzt durch das Protokoll vom 16. November 1982, das Protokoll vom 12. Februar 1982, in Kraft seit 7. April 1988
und ergänzt durch das Protokoll vom 12. Februar 2004, noch nicht in Kraft
16 Vertragsparteien (10/10), Depositar: OECD
Gesetz dazu vom 8. Juli 1975 (BGBl. II 1975, Nr. 42, S. 957), zuletzt geändert durch Artikel 30 des Gesetzes vom 9. September 2001 (BGBl. I 2001, Nr. 47, S. 2331)
in Kraft für Deutschland seit 30. September 1975 (BGBl. II 1976, Nr. 12, S. 308),
Gesetz dazu vom 21. Mai 1985 (BGBl. II 1985, Nr. 19, S. 690)
in Kraft für Deutschland seit 7. Oktober 1988 (BGBl. II 1989, Nr. 6, S. 144)
Gesetz zum Protokoll 2004 mit amtlicher Übersetzung vom 29. August 2008 (BGBl.II 2008, Nr. 24, S. 902)
Hinweis: Die Bestimmungen des Pariser Atomhaftungs-Übereinkommens gelten in Verbindung mit §§ 25 ff. des Atomgesetzes in der Bundesrepublik Deutschland unmittelbar, d.h. die Haftung für nukleare Schäden bestimmt sich nach den Bestimmungen des Übereinkommens in Verbindung mit dem Atomgesetz.

[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, in Kraft seit 4. Dezember 1974,
ergänzt durch das Protokoll vom 16. November 1982, in Kraft seit 1. August 1991
und ergänzt durch das Protokoll von 2004, noch nicht in Kraft
12 Vertragsparteien (10/10), Depositar: OECD
Gesetz dazu vom 8. Juli 1975 (BGBl. II 1975, Nr. 42, S. 957), zuletzt geändert durch Artikel 30 des Gesetzes vom 9. September 2001 (BGBl. I 2001, Nr. 47, S. 2331)
in Kraft für Deutschland seit 1. Januar 1976 (BGBl. II 1976, Nr. 12, S. 308)
Gesetz dazu vom 21. Mai 1985 (BGBl. II 1985, Nr. 19, S. 690)
in Kraft für Deutschland seit 1. August 1991 (BGBl. II 1995, Nr. 24, S. 657)
Gesetz zum Protokoll 2004 mit amtlicher Übersetzung vom 29. August 2008 (BGBl.II 2008, Nr. 24, S. 902)

Hinweis: Im Brüsseler Zusatzübereinkommen verpflichten sich die Vertragsparteien, bei Schäden, die über den Haftungsbetrag des haftpflichtigen Inhabers der Kernanlage hinausgehen, weitere Entschädigungsbeträge aus öffentlichen Mitteln bereitzustellen. Dieses Übereinkommen gilt in der Bundesrepublik Deutschland nicht unmittelbar, sondern schafft nur völkerrechtliche Verpflichtungen zwischen den Vertragsstaaten.

[1E-14] Übereinkommen über Nachzahlungen bei Nuklearschäden (Convention on Supplementary Compensation for Nuclear Damage, INFCIRC/567)vom 29. September 1997, noch nicht in Kraft
4 Vertragsparteien (10/10), Depositar: IAEA
Hinweis: 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 Provisions

[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 - Artikel 2 bis 4 hiervon aufgehoben durch Artikel 67 des Gesetzes vom 8. Dezember 2010 (BGBl.I 2010, Nr. 63, S. 1864); BGBl. II 1992, S. 1251, 1286; BGBl. II 1993, S. 1947; BGBl. II 1994, S. 2022; ABl. 1995, L 1)
Der Vertrag ist in seiner ursprünglichen Fassung am 1. Januar 1958 in Kraft getreten (BGBl. II 1958 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)

[1F-2] Verifikationsabkommen siehe [1E-10]

[1F-3] Verordnung (EURATOM) 302/2005der Kommission vom 8. Februar 2005 über die Anwendung der EURATOM-Sicherungsmaßnahmen (ABl. 2005, L54)

[1F-4] Bekanntmachung über die Meldung an die Behörden der Mitgliedstaaten auf dem Gebiet der Sicherungsmaßnahmen gemäß Artikel 79 Abs. 2 des EURATOM-Vertrages vom 19. August 1999 (BGBl. II 1999, Nr. 25, S. 811)

[1F-5] Richtlinie 2009/71/EURATOM des Rates vom 25. Juni 2009 über einen Gemeinschaftsrahmen für die nukleare Sicherheit kerntechnischer Anlagen (ABl. 2009 L172)

[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 (ABl. EG 2000, Nr. L191)
Hinweis: Überwachung des Radioaktivitätsgehaltes der Umwelt zur Ermittlung der Exposition der Gesamtbevölkerung

[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), zuletzt geändert durch die Richtlinie 2009/31/EG des EP und des Rates vom 23. April 2009 (ABl. 2009, L 140), letzte konsolidierte Fassung 2009

Hinweis: Umsetzung s. UVP-Gesetz (1B-3)

[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

[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), mehrfach geändert, letzte konsolidierte Fassung 2007

[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)
Hinweis: Das Datum der Umsetzung der RL ist nicht präzisiert; derzeit sind z. B. Druckbehälter, verfahrbare Jahrmarktsgeräte und Maschinen für nukleare Verwendung noch ausgenommen.

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)
Hinweis: Verpflichtung der Mitgliedsstaaten, der EU-Kommission Entwürfe von Rechts- und Verwaltungsvorschriften vor Verabschiedung zuzuleiten

[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)

- 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), geändert durch Richtlinie 2007/30/EG vom 20. Juni 2007 (ABl. 2007, L165)
Hinweis: Gemäß Artikel 7 der Richtlinie sind die Mitgliedstaaten verpflichtet, die Beschäftigung von jungen Menschen bei Arbeiten, die eine schädliche Einwirkung von Strahlen mit sich bringen, zu verbieten.

[1F-22] Richtlinie 2003/122/EURATOM des Rates vom 22. Dezember 2003 zur Kontrolle hoch radioaktiver umschlossener Strahlenquellen und herrenloser Strahlenquellen (ABl. 2003, Nr. L346 vom 31. Dezember 2003 S. 57-66)
Hinweis: Ausgenommen sind Tätigkeiten, die unter den EURATOM-Vertrag oder eines der speziellen Nuklearhaftungsregime fallen

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 (ECURIE) (ABl. EG 1987, Nr. L371)

[1F-29] Richtlinie 89/618/EURATOM des Rates vom 27. November 1989 über die Unterrichtung der Bevölkerung über die bei einer radiologischen Notstandssituation geltenden Verhaltensmaßregeln und zu ergreifenden Gesundheitsschutzmaßnahmen (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 Nahrungsmitteln und Futtermitteln im Fall eines nuklearen Unfalls oder einer anderen radiologischen 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), konsolidierte Fassung 1989,
- 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] Verordnung (EG) 733/2008 des Rates vom 15. Juli 2008 über die Einfuhrbedingungen für landwirtschaftliche Erzeugnisse mit Ursprung in Drittländern nach dem Unfall im Kernkraftwerk Tschernobyl (ABl. 2008, Nr. L201),
Hinweis: vorläufig gültig bis 31. März 2020

- Verordnung (EWG) 1983/88 der Kommission vom 5. Juli 1988 mit Durchführungsbestimmungen zu der Verordnung (EWG) 3955/87 (ABl. EG 1988, Nr. L174),
- Verordnung (EWG) 4003/89 des Rates vom 21. Dezember 1989 zur Änderung 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 Drittländern 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

[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)

[2-3] Allgemeine Verwaltungsvorschrift zur Ausführung des Gesetzes über die Umweltverträglichkeitsprüfung (UVPVwV) vom 18. September 1995 (GMBl. 1995, Nr. 32, S. 671)

[2-4] Allgemeine Verwaltungsvorschrift zum Integrierten Mess- und Informationssystem zur Überwachung der Radioaktivität in der Umwelt nach dem Strahlenschutzvorsorgegesetz (AVV-IMIS) vom 13. September 2006 (BAnz. 2006, Nr. 244a)

[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-StrahLe) vom 28. Juni 2000 (GMBl. 2000, Nr. 25, S. 490)

[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)

3 Announcements by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the Federal Ministry for the Interior (Extract)

[3-1] Sicherheitskriterien für Kernkraftwerke vom 21. Oktober 1977 (BAnz. 1977, Nr. 206)
Hinweis: Soll ersetzt werden durch Sicherheitskriterien für Kernkraftwerke (Revision D) vom April 2009

[3-2] Richtlinie für den Fachkundenachweis von Kernkraftwerkspersonal vom 14. April 1993 (GMBl. 1993, Nr. 20, S. 358),
Hinweis: Nach einer probeweisen Anwendung für 3 Jahre (ab 1. Januar 2005) wurde vom Fachausschuss für Reaktorsicherheit einer Ergänzung für das verantwortliche Kernkraftwerkspersonal am 17. November 2008 zugestimmt (Aktenzeichen RS I6 - 13 831-2/1)

[3-4] Richtlinien über die Anforderungen an Sicherheitsspezifikationen für Kernkraftwerke vom 27. April 1976 (GMBl. 1976, Nr. 15, S. 199)

[3-5] Merkpostenaufstellung mit Gliederung für einen Standardsicherheitsbericht für Kernkraftwerke mit Druckwasserreaktor oder Siedewasserreaktor vom 26. Juli 1976 (GMBl. 1976, Nr. 26, 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 (GMBl. 1981, Nr. 33, S. 518)

[3-8] Grundsätze für die Vergabe von Unteraufträgen durch Sachverständige vom 29. Oktober 1981 (GMBl. 1981, Nr. 33, 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 (GMBl. 1982, Nr. 26, 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 (GMBl. 1983, Nr. 13, S. 220), in Überarbeitung

[3-15] 1. Rahmenempfehlungen für den Katastrophenschutz in der Umgebung kerntechnischer Anlagen vom 27. Oktober 2008 (GMBl. 2008, Nr. 62/63, S. 1278)
2. Radiologische Grundlagen für Entscheidungen über Maßnahmen zum Schutz der Bevölkerung bei unfallbedingten Freisetzungen von Radionukliden vom 27. Oktober 2008 (GMBl. 2008, Nr. 62/63, S. 1278) mit der Anlage „Verwendung von Jodtabletten zur Jodblockade der Schilddrüse bei einem kerntechnischen Unfall“

[3-23] Richtlinie zur Emissions- und Immissionsüberwachung kerntechnischer Anlagen (REI) vom 7. Dezember 2005 (GMBl. 2006, Nr. 14-17, S. 254)

[3-24] Richtlinie über Dichtheitsprüfungen an umschlossenen radioaktiven Stoffen vom 20. Januar und 4. Februar 2004 (GMBl. 2004, Nr. 27, S. 530)

[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 (GMBl.

2001, Nr. 8, S. 153)

[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 (GMBl. 1977, Nr. 4, S. 48), geändert durch Bekanntmachung vom 18. Oktober 1977 (GMBl. 1977, Nr. 30, S. 664) und die REI (GMBl. 1993, Nr. 29, S. 502), ersetzt durch Empfehlung der SSK und RSK (BAnz. 2011, Nr. 65a, siehe RSH, Kapitel 4, Punkt 4-13)

[3-32] Änderung der Empfehlungen zur Planung von Notfallschutzmaßnahmen durch Betreiber von Kernkraftwerken vom 18. Oktober 1977 (GMBl. 1977, S. 664)

[3-33] 1. 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)
Hinweis: Soll ersetzt werden durch Sicherheitskriterien für Kernkraftwerke (Revision D) vom April 2009
2. 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 (GMBl. 1984, Nr. 2, S. 21)

[3-37] Empfehlung über den Regelungsinhalt von Bescheiden bezüglich der Ableitung radioaktiver Stoffe aus Kernkraftwerken mit Leichtwasserreaktor vom 8. August 1984 (GMBl. 1984, Nr. 21, S. 327)

[3-38] Richtlinie für Programme zur Erhaltung der Fachkunde des verantwortlichen Schichtpersonals in Kernkraftwerken vom 1. September 1993 (GMBl. 1993, Nr. 36, S. 645)

[3-39] Richtlinie für den Inhalt der Fachkundeprüfung des verantwortlichen Schichtpersonals in Kernkraftwerken vom 23. April 1996 (GMBl. 1996, Nr. 26, S. 555)

[3-40] Richtlinie über die im Strahlenschutz erforderliche Fachkunde (Fachkunderichtlinie Technik nach StrlSchV) vom 21. Juni 2004 (GMBl. 2004, Nr. 40/41, S. 779), Änderung vom 19. April 2006 (GMBl. 2006, Nr. 38, S. 735)

[3-41] Richtlinie für das Verfahren zur Vorbereitung und Durchführung von Instandhaltungs- und Änderungsarbeiten in Kernkraftwerken vom 1. Juni 1978 (GMBl. 1978, Nr. 22, S. 342), in Überarbeitung

[3-42-1] Richtlinie für die physikalische Strahlenschutzkontrolle zur Ermittlung der Körperdosen
Teil 1: Ermittlung der Körperdosis bei äußerer Strahlenexposition (§§ 40, 41, 42 StrlSchV; §§ 35 RöV) vom 8. Dezember 2003 (GMBl. 2004, Nr. 22, S. 410)

[3-42-2] Richtlinie für die physikalische Strahlenschutzkontrolle zur Ermittlung der Körperdosen
Teil 2: Ermittlung der Körperdosis bei innerer Strahlenexposition (Inkorporationsüberwachung) (§§ 40, 41 und 42 StrlSchV) vom 12. Januar 2007 (GMBl. 2007, Nr. 31/32, S. 623), Anhänge 1 bis 6, Anhang 7.1, Anhang 7.2, Anhang 7.3, Anhang 7.4
Hinweis: hiermit wird die Richtlinie über Anforderungen an Inkorporationsmeßstellen vom 30. September 1996 (GMBl. 1996, Nr. 46, S. 996) aufgehoben und ersetzt.

[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 - IWRS I vom 10. Juli 1978 (GMBl. 1978, Nr. 28, S. 418), in Überarbeitung

[3-43-2] Richtlinie für den Strahlenschutz des Personalsbei 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 (GMBl. 2005, Nr. 13, S. 258)

[3-44] Kontrolle der Eigenüberwachung radioaktiver Emissionen aus Kernkraftwerken vom 5. Februar 1996 (GMBl. 1996, Nr. 9/10, S. 247)

[3-49] Interpretationen zu den Sicherheitskriterien für Kernkraftwerke;
Einzelfehlerkonzept - Grundsätze für die Anwendung des Einzelfehlerkriteriums vom 2. März 1984 (GMBl. 1984, Nr. 13, S. 208)

[3-50] Interpretationen zu den Sicherheitskriterien für Kernkraftwerke vom 17. Mai 1979 (GMBl. 1979, Nr. 14, 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 (GMBl. 1980, Nr. 5, 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 nach § 7 AtG zur Spaltung von Kernbrennstoffen
(Meldeformular, Stand 04/08)

[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 (GMBl. 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 (GMBl. 1983, Nr. 8, S. 146)

[3-55] Musterbenutzungsordnung der Landessammelstellen für radioaktive Abfälle in der Bundesrepublik Deutschland vom 17. März 1981 (GMBl. 1981, Nr. 11, S. 163)

[3-55-1] Grundsätzliche Konzeption für den Ausbau der Landessammelstellen für radioaktive Abfälle vom 26. Oktober 1981 (GMBl. 1981, Nr. 32, S. 511)

[3-57] Anforderungen an den Objektsicherungsdienst und an Objektsicherungsbeauftragte in kerntechnischen Anlagen und Einrichtungen (OSD-Richtlinie) vom 4. Juli 2008 (GMBl. 2008, Nr. 39, S. 810)

[3-57-3] Richtlinie für den Schutz von Kernkraftwerken mit Leichtwasserreaktoren gegen Störmaßnahmen oder sonstige Einwirkungen Dritter vom 6. Dezember 1995 (GMBl. 1996, Nr. 2, S. 32) (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)
Hinweis: Inhaltlich ersetzt durch Richtlinie zur Kontrolle radioaktiver Reststoffe und radioaktiver Abfälle vom 19. November 2008 [vgl. 3-60] aber offiziell nicht zurückgezogen

[3-60] Richtlinie zur Kontrolle radioaktiver Reststoffe und radioaktiver Abfälle vom 19. November 2008 (BAnz. 2008, Nr. 197)

[3-61] Richtlinie für die Fachkunde von Strahlenschutzbeauftragten in Kernkraftwerken und sonstigen Anlagen zur Spaltung von Kernbrennstoffen vom 10. Dezember 1990 (GMBl. 1991, Nr. 4, S. 56), in Überarbeitung

[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 (GMBl. 1991, Nr. 9, S. 228)

[3-63] Richtlinie für den Schutz von radioaktiven Stoffen gegen Störmaßnahmen oder sonstige Einwirkungen Dritter bei der Beförderung vom 4. Dezember 2003 (GMBl. 2004, Nr. 12, S. 238) (ohne Wortlaut)

[3-64] Anforderungen an das Sicherungspersonal bei Beförderungen von radioaktiven Stoffen vom 4. Juni 1996 (GMBl. 1996, Nr. 29, S: 621 und Nr. 33, S. 673)

[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 (GMBl. 2002, Nr. 6, S. 136)

[3-71] Richtlinie für die Fachkunde von verantwortlichen Personen in Anlagen zur Herstellung von Brennelementen für Kernkraftwerke vom 30. November 1995 (GMBl. 1996, Nr. 2, S. 29)

[3-73] Leitfaden zur Stilllegung, zum sicheren Einschluß und zum Abbau von Anlagen oder Anlagenteilen nach § 7 des Atomgesetzes
vom 26. Juni 2009 (BAnz. 2009, Nr. 162a)

[3-74-1] Leitfäden zur Durchführung von Periodischen Sicherheitsüberprüfungen (PSÜ) für Kernkraftwerke in der Bundesrepublik Deutschland, in Überarbeitung
- Grundlagen zur Periodischen Sicherheitsprüfung für Kernkraftwerke
- Leitfaden Sicherheitsstatusanalyse
- Leitfaden Probabilistische Sicherheitsanalyse
Bekanntmachung vom 18. August 1997 (BAnz. 1997, Nr. 232a)

[3-74-2] Leitfaden zur Durchführung von Periodischen Sicherheitsüberprüfungen (PSÜ) für Kernkraftwerke in der Bundesrepublik Deutschland, in Überarbeitung
- Leitfaden Deterministische Sicherungsanalyse
Bekanntmachung vom 25. Juni 1998 (BAnz. 1998, Nr. 153)

[3-74-3] Leitfaden zur Durchführung der Sicherheitsüberprüfung gemäß § 19a des Atomgesetzes
- 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

[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

[4-4] Leitlinien zur Stilllegung kerntechnischer Anlagen, Empfehlung der ESK, Anlage zum Ergebnisprotokoll der 13. Sitzung der Entsorgungskommission am 9. September 2010 (BANZ. 2010, Nr. 187)

[4-5] ESK-Empfehlungen für Leitlinien zur Durchführung von periodischen Sicherheitsüberprüfungen für Zwischenlager für bestrahlte Brennelemente und Wärme entwickelnde radioaktive Abfälle, Empfehlung der ESK, Anlage zum Ergebnisprotokoll der 14. Sitzung der Entsorgungskommission am 4. November 2010

5 Rules of the Nuclear Safety Standards Commission (KTA)

Regel-Nr. KTA	Titel	Letzte Fassung	Veröffentlichung im Bundesanzeiger Nr. vom	Frühere Fassungen	Bestätigung der Weitergültigkeit	Engl. Übersetzung
	<u>1000 KTA-interne Verfahrensregeln</u>					
	<u>1100 Begriffe und Definitionen</u>		-		-	-
	(Begriffesammlung der KTA-GS)	01/06		06/91 01/96 01/04		
	<u>1200 Allgemeines, Administration, Organisation</u>					
1201*	Anforderungen an das Betriebshandbuch	11/09	3 a - 07.01.10	02/78 03/81 12/85 06/98		+
1201*	Anforderungen an das Betriebshandbuch	11/07	239 – 21.12.07	-	-	-
1202*	Anforderungen an das Prüfhandbuch	11/09	3 a - 07.01.10	06/84	-	+
1202*	Anforderungen an das Prüfhandbuch	11/07	239 – 21.12.07	-	-	-
1203*	Anforderungen an das Notfallhandbuch	11/09	3 a – 07.01.10	-	-	-
	<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	11/08	158 a - 24.08.89 Berichtigung 118 – 29.06.91	06/82 06/89	-	+
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	06/96	216 a - 19.11.96	02/80 12/87	19.06.01	+
1404*	Dokumentation beim Bau und Betrieb von Kernkraftwerken	06/01	235 a - 15.12.01	06/89	-	+
1408.1*	Qualitätssicherung von Schweißzusätzen und -hilfsstoffen für druck- und aktivitätsführende Komponenten in Kernkraftwerken; Teil 1: Eignungsprüfung	11/08	15 a - 29.01.09	06/85	-	+

Regel-Nr. KTA	Titel	Letzte Fassung	Veröffentlichung im Bundesanzeiger Nr. vom	Frühere Fassungen	Bestätigung der Weitergültigkeit	Engl. Übersetzung
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	11/08	15 a - 29.01.09	06/85	-	+
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	08/11	15 a - 29.01.09	06/85	-	+
1408.3*	Qualitätssicherung von Schweißzusätzen und -hilfsstoffen für druck- und aktivitätsführende Komponenten in Kernkraftwerken; Teil 3: Verarbeitung	11/07	239 – 21.12.07	-	-	-
	1500 Strahlenschutz und Überwachung					
1501	Ortsfestes System zur Überwachung von Ortsdosisleistungen innerhalb von Kernkraftwerken	11/10	199 a - 30.12.10	10/77 06/91 11/04	-	+
1502	Überwachung der Radioaktivität in der Raumluft von Kernkraftwerken	11/05	101 a - 31.05.06	06/86 (1502.1)	-	+
(1502.2)	Überwachung der Radioaktivität in der Raumluft von Kernkraftwerken; Teil 2: Kernkraftwerke mit Hochtemperaturreaktor	06/89	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	06/02	172 a - 13.09.02 Berichtigung 55 – 20.03.03	02/79 06/93	13.11.07	+

Regel-Nr. KTA	Titel	Letzte Fassung	Veröffentlichung im Bundesanzeiger Nr. vom	Frühere Fassungen	Bestätigung der Weitergültigkeit	Engl. Übersetzung
1503.2	Überwachung der Ableitung gasförmiger und aerosolgebundener radioaktiver Stoffe; Teil 1: Überwachung der Ableitung radioaktiver Stoffe mit der Kaminfortluft bei Störfällen	06/99	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	06/99	243 b - 23.12.99	-	16.11.04	+
1504	Überwachung der Ableitung radioaktiver Stoffe mit Wasser	11/07	9 a - 17.01.08	06/78 06/94	-	+
1505	Nachweis der Eignung von Strahlungsmesseinrichtungen	11/03	26 a - 07.02.04	-	-	-
(1506)	Messung der Ortsdosisleistung in Sperrbereichen von Kernkraftwerken (diese Regel wurde am 16.11.04 zurückgezogen)	06/86	162 a - 03.09.86 Berichtigung 229 - 10.12.86	-	11.06.96	+
1507	Überwachung der Ableitungen radioaktiver Stoffe bei Forschungsreaktoren	06/98	172 a - 15.09.98	03/84	11.11.03	-
1508	Instrumentierung zur Ermittlung der Ausbreitung radioaktiver Stoffe in der Atmosphäre	11/06	245b - 30.12.06	09/88	-	+
	2100 Gesamtanlage					
2101.1	Brandschutz in Kernkraftwerken; Teil 1: Grundsätze des Brandschutzes	12/00	106 a - 09.06.01 Berichtigung 239 – 21.12.07	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)	06/00	231 a - 08.12.00	06/89	22.11.05	+
	2200 Einwirkungen von außen					
2201.1*	Auslegung von Kernkraftwerken gegen seismische Einwirkungen; Teil 1: Grundsätze	06/90	20 a - 30.01.91	06/75	20.06.00	+

Regel-Nr. KTA	Titel	Letzte Fassung	Veröffentlichung im Bundesanzeiger Nr. vom	Frühere Fassungen	Bestätigung der Weitergültigkeit	Engl. Übersetzung
2201.2*	Auslegung von Kernkraftwerken gegen seismische Einwirkungen; Teil 2: Baugrund	06/90	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	06/90	20 a - 30.01.91 Berichtigung 115 - 25.06.96	-	20.06.00	+
2201.5	Auslegung von Kernkraftwerken gegen seismische Einwirkungen; Teil 5: Seismische Instrumentierung	06/96	216 a - 19.11.96	06/77 06/90	07.11.06	+
2201.6*	Auslegung von Kernkraftwerken gegen seismische Einwirkungen; Teil 6: Maßnahmen nach Erdbeben	06/92	36 a - 23.02.93	-	18.06.02	+
2206*	Auslegung von Kernkraftwerken gegen Blitzeinwirkungen	11/09	3 a - 07.01.10	06/92 06/00	-	-
2207	Schutz von Kernkraftwerken gegen Hochwasser	11/04	35 a - 19.02.05	06/82 06/92	10.11.09	+
	2500 Bautechnik					
2501	Bauwerksabdichtungen von Kernkraftwerken	11/10	72 a - 11.05.11	09/88 06/02 11/04	-	+
2502*	Mechanische Auslegung von Brennelementlagerbecken in Kernkraftwerken mit Leichtwasserreaktoren	06/90	20 a - 30.01.91	-	20.06.00	+
	3000 Systeme allgemein					
	3100 Reaktorkern und Reaktorregelung					
3101.1*	Auslegung der Reaktorkerne von Druck- und Siedewasserreaktoren; Teil 1: Grundsätze der thermohydraulischen Auslegung	02/80	92 - 20.05.80	-	20.06.00	+
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	06/78	189 a - 06.10.78 Beilage 23/78	-	15.06.93	+

Regel-Nr. KTA	Titel	Letzte Fassung	Veröffentlichung im Bundesanzeiger Nr. vom	Frühere Fassungen	Bestätigung der Weitergültigkeit	Engl. Übersetzung
(3102.2)	Auslegung der Reaktorkerne von gasgekühlten Hochtemperaturreaktoren; Teil 2: Wärmeübergang im Kugelhaufen	06/83	194 - 14.10.83 Beilage 47/83	-	15.06.93	+
(3102.3)	Auslegung der Reaktorkerne von gasgekühlten Hochtemperaturreaktoren; Teil 3: Reibungsdruckverlust in Kugelhaufen	03/81	136 a - 28.07.81 Beilage 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 Berichtigung 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	06/86	162 a - 03.09.86	-	15.06.93	+
3103*	Abschaltsysteme von Leichtwasserreaktoren	03/84	145 a - 04.08.84 Beilage 39/84	-	15.06.99	+
3104	Ermittlung der Abschaltreaktivität	10/79	19 a - 29.01.80 Beilage 1/80	-	10.11.09	+
	3200 Primär- und Sekundärkreis					
3201.1	Komponenten des Primärkreises von Leichtwasserreaktoren; Teil 1: Werkstoffe und Erzeugnisformen	06/98	170 a - 11.09.98	02/79 11/82 06/90	11.11.03	+
3201.2*	Komponenten des Primärkreises von Leichtwasserreaktoren; Teil 2: Auslegung, Konstruktion und Berechnung	06/96	216 a - 19.11.96 Berichtigung 129 – 13.07.00	10/80 03/84	-	+
3201.3	Komponenten des Primärkreises von Leichtwasserreaktoren; Teil 3: Herstellung	11/07	9 a - 17.01.08 Berichtigung 82 a – 05.06.09	10/79 12/87 06/98	-	+
3201.4*	Komponenten des Primärkreises von Leichtwasserreaktoren; Teil 4: Wiederkehrende Prüfungen und Betriebsüberwachung	11/10	199 a - 30.12.10	06/82; 06/90 06/99	-	+

Regel-Nr. KTA	**Titel**	**Letzte Fassung**	**Veröffentlichung im Bundesanzeiger Nr. vom**	**Frühere Fassungen**	**Bestätigung der Weitergültigkeit**	**Engl. Übersetzung**
3203	Überwachung der Strahlenversprödung von Werkstoffen des Reaktordruckbehälters von Leichtwasserreaktoren	06/01	235 b - 15.12.01	03/84	07.11.06	+
3204*	Reaktordruckbehälter-Einbauten	11/08	15 a - 29.01.09	03/84 06/98	-	-
3204*	Reaktordruckbehälter-Einbauten	11/07	239 – 21.12.07	-	-	-
3205.1	Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen; Teil 1: Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen für Primärkreiskomponenten in Leichtwasserreaktoren	06/02	189 a - 10.10.02	06/82 06/91	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	06/90	41 a - 28.02.91	-	20.06.00	+
3205.3	Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen; Teil 3: Serienmäßige Standardhalterungen	11/06	163 - 31.08.07	06/89	-	+
3211.1*	Druck- und aktivitätsführende Komponenten von Systemen außerhalb des Primärkreises; Teil 1: Werkstoffe	06/00	194 a - 14.10.00 Berichtigung 132 - 19.07.01	06/91	-	+
3211.2*	Druck- und aktivitätsführende Komponenten von Systemen außerhalb des Primärkreises; Teil 2: Auslegung, Konstruktion und Berechnung	06/92	165 - 03.09.93 Berichtigung 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	06/90	-	-
3211.4*	Druck- und aktivitätsführende Komponenten von Systemen außerhalb des Primärkreises; Teil 4: Wiederkehrende Prüfungen und Betriebsüberwachung	06/96	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)]	+

Regel-Nr. KTA	Titel	Letzte Fassung	Veröffentlichung im Bundesanzeiger Nr. vom	Frühere Fassungen	Bestätigung der Weitergültigkeit	Engl. Übersetzung
3303*	Wärmeabfuhrsysteme für Brennelementlagerbecken von Kernkraftwerken mit Leichtwasserreaktoren	06/90	41 a - 28.02.91	-	20.06.00	+
	3400 Sicherheitseinschluss					
3401.1*	Reaktorsicherheitsbehälter aus Stahl; Teil 1: Werkstoffe und Erzeugnisformen	09/88	37 a - 22.02.89	06/80 11/82	16.06.98	+
3401.2	Reaktorsicherheitsbehälter aus Stahl; Teil 2: Auslegung, Konstruktion und Berechnung	06/85	203 a - 29.10.85	06/80	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	06/91	7 a - 11.01.92	03/81	07.11.06	+
3402	Schleusen am Reaktorsicherheitsbehälter von Kernkraftwerken - Personenschleusen	11/09	72 a - 12.05.10	11/76	-	+
3403*	Kabeldurchführungen im Reaktorsicherheitsbehälter von Kernkraftwerken	11/10	199 a - 30.12.10	11/76 10/80	-	+
3404	Abschließung der den Reaktorsicherheitsbehälter durchdringenden Rohrleitungen von Betriebssystemen im Falle einer Freisetzung von radioaktiven Stoffen in den Reaktorsicherheitsbehälter	11/08	82 a – 05.06.09	09/88	-	+
3405*	Dichtheitsprüfung des Reaktorsicherheitsbehälters	11/10	199 a – 30.12.10	02/79	-	+
3407	Rohrdurchführungen durch den Reaktorsicherheitsbehälter	06/91	113 a - 23.06.92	-	07.11.06	+
3409	Schleusen am Reaktorsicherheitsbehälter von Kernkraftwerken - Materialschleusen	11/09	72 a – 12.05.10	06/79	-	+
3413	Ermittlung der Belastungen für die Auslegung des Volldrucksicherheitsbehälters gegen Störfälle innerhalb der Anlage	06/89	229 a - 07.12.89	-	10.11.09	+
	3500 Instrumentierung und					
3501*	Reaktorschutzsystem und Überwachungseinrichtungen des Sicherheitssystems	06/85	203 a - 29.10.85	03/77	20.06.00	+
3502	Störfallinstrumentierung	06/99	243 b - 23.12.99	11/82 11/84	16.11.04	+

Regel-Nr. KTA	Titel	Letzte Fassung	Veröffentlichung im Bundesanzeiger Nr. vom	Frühere Fassungen	Bestätigung der Weitergültigkeit	Engl. Übersetzung
3503	Typprüfung von elektrischen Baugruppen des Reaktorschutzsystems	11/05	101 a - 31.05.06	06/82 11/86	-	+
3504	Elektrische Antriebe des Sicherheitssystems in Kernkraftwerken	11/06	245 b - 30.12.06	09/88	-	-
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	06/02	27 a - 08.02.03	11/86	-	+
	3600 Aktivitätskontrolle und -führung					
3601	Lüftungstechnische Anlagen in Kernkraftwerken	11/05	101 a - 31.05.06	06/90	16.11.10	+
3602	Lagerung und Handhabung von Brennelementen, Steuerelementen und Neutronenquellen in Kernkraftwerken mit Leichtwasserreaktoren	11/03	26 a - 07.02.04	06/82 06/84 06/90	11.11.08	+
3603*	Anlagen zur Behandlung von radioaktiv kontaminiertem Wasser in Kernkraftwerken	11/09	3 a - 07.01.10	02/80 06/91		+
3604	Lagerung, Handhabung und innerbetrieblicher Transport radioaktiver Stoffe (mit Ausnahme von Brennelementen) in Kernkraftwerken	11/05	101 a - 31.05.06	06/83	16.11.10	+
3605	Behandlung radioaktiv kontaminierter Gase in Kernkraftwerken mit Leichtwasserreaktoren	06/89	229 a - 07.12.89	-	16.11.04	+
	3700 Energie- und Medienversorgung					
3701	Übergeordnete Anforderungen an die elektrische Energieversorgung in Kernkraftwerken	06/99	243 b - 23.12.99	3701.1 (06/78) 3701.2 (06/82) 06/97	16.11.04	+
3702	Notstromerzeugungsanlagen mit Dieselaggregaten in Kernkraftwerken	06/00	159 a - 24.08.00	3702.1 (06/80) 3702.2 (06/91)	22.11.05	-
3703	Notstromanlagen mit Batterien und Gleichrichtergeräten in Kernkraftwerken	06/99	243 b - 23.12.99	06/86	16.11.04	+

Regel-Nr. KTA	Titel	Letzte Fassung	Veröffentlichung im Bundesanzeiger Nr. vom	Frühere Fassungen	Bestätigung der Weitergültigkeit	Engl. Übersetzung
3704	Notstromanlagen mit Gleichstrom-Wechselstrom-Umformern in Kernkraftwerken	06/99	243 b - 23.12.99	06/84	16.11.04	+
3705	Schaltanlagen, Transformatoren und Verteilungsnetze zur elektrischen Energieversorgung des Sicherheitssystems in Kernkraftwerken	11/06	245 b - 30.12.06	09/88 06/99	-	-
3706	Sicherstellung des Erhalts der Kühlmittelverlust-Störfallfestigkeit von Komponenten der Elektro- und Leittechnik in Betrieb befindlicher Kernkraftwerke	06/00	159 a - 24.08.00	-	16.11.10	-
	3900 Systeme, sonstige					
3901	Kommunikationseinrichtungen für Kernkraftwerke	11/04	35 a - 19.02.05	03/77 03/81	-	+
3902*	Auslegung von Hebezeugen in Kernkraftwerken	06/99	144 a - 05.08.99	11/75 06/78 11/83 06/92	16.11.04	+
3903*	Prüfung und Betrieb von Hebezeugen in Kernkraftwerken	11/10	190 -15.12.10	11/82 06/93 06/99	-	+
3904	Warte, Notsteuerstelle und örtliche Leitstände in Kernkraftwerken	11/07	9 a - 17.01.08	09/88	-	+
3905*	Lastanschlagpunkte an Lasten in Kernkraftwerken	06/99	200 a - 22.10.99 Berichtigung 129 - 13.07.00 136 - 22.07.00	06/94	-	+

* Regel in Überarbeitung
( ) HTR-Regel, die nicht mehr in die Überprüfung gemäß Abschnitt 5.2 der Verfahrensordnung des KTA einbezogen und nicht mehr über die Carl Heymanns Verlag KG beziehbar ist.
1) Der KTA hat auf seiner 43. Sitzung am 27.06.89 „Hinweise für den Benutzer der Regel KTA 3301 (11/84)“ beschlossen.
2) In dieser Regel wurden die HTR-Festlegungen gestrichen.

(e) References to Official National and International Reports Related to Safety

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9. Jahresbericht 2001 Bundesamt für Strahlenschutz; Salzgitter 2000
10. Methoden und Anwendungen geostatistischer Analysen; Von K.-J. Röhling; BMU 1999-529
11. Sicherheit in der Nachbetriebsphase von Endlagern für radioaktive Abfälle; Von K.-J. Röhling, B. Baltes, A. Becker, P. Bogorinski, H. Fischer K. Fischer-Appelt, V. Javeri, L. Lambers, K.-H. Martens, G. Morlock, B. Pöltl; BMU 1999-535
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15. Unsicherheits- und Sensitivitätsanalysen für Grundwasser- und Transportmodelle auf der Basis geostatistischer Untersuchungen; Von K.-J. Röhling, B. Pöltl; BMU 2000-551
16. Stellungnahme zu sicherheitstechnisch relevanten Erkenntnissen im Endlager Morsleben und Konsequenzen; Von R. S. Wernicke; BMU 2000-552

17. Simulation von Lüftungssystemen in Anlagen des Brennstoffkreislauf durch Erweiterung des Rechenprogramms FIPLOC; Von G. Weber; BMU 2000-553
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30. Erarbeitung einer optimierten Entsorgungsstrategie für Abfälle und Reststoffe aus Kernkraftwerken (Entsorgungsstrategie für radioaktive Abfälle); Von A. Nüsser, S. Thierfeldt, E. Kugeler, D. Gründler, D. Maric; BMU 2002-607
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(f) Other Relevant Material

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DIN 25401-2: Begriffe der Kerntechnik; Reaktorauslegung
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<u>Additional report concerning the remediation of the Wismut GmbH</u>

WISMUT Annex

to the

Report of the Federal Republic of Germany for the Fourth Review Meeting of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (IAEA Joint Convention), May 2012

1 Scope of the Wismut project

Background to the remediation of legacies left behind by uranium ore mining and milling operations in Germany

During the period of uranium ore mining in the former German Democratic Republic from 1946 through 1990, a total of 231 000 Mg of uranium were produced. In the Transition Agreement of 9 October 1990, the governments of the Federal Republic of Germany and the Union of Soviet Socialist Republics (USSR) agreed to cease operations of the Soviet-German joint-stock company (SDAG) Wismut on 1 January 1991.

Under the terms of the government agreement of 16 May 1991, joint operations in the context of SDAG Wismut were terminated, and the Soviet share holdings of 50 % were 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,
- a corporate restructuring,
- the orderly decommissioning of the existing mining and processing units and the rapid remediation and recultivation of the legacies left behind by uranium mining and processing operations.

Since its foundation in December 1991, Wismut GmbH is as a federally-owned company, with the Federal Ministry of Economics and Technology (BMWi) being the only shareholder.

The scope of the Wismut remediation project, the tasks as well as the dimension of the legacies at the time when uranium production was terminated in 1990 have been comprehensively outlined in the reports for the Second and Third Review Meeting.

2 Status of remediation

Since 1990 the remediation of the legacy sites of uranium ore mining in the *Länder* Saxony and Thuringia in the Eastern part of Germany has made considerable progress, this is true in particular of underground stabilisation of mine workings and physical aboveground works involving mine dumps, plant areas, and tailings management areas. Of the total of around 7.1 billion Euros (re-calculated on the basis of the 2010 remediation programme) earmarked by the Federal Republic of Germany to implement the WISMUT remediation project, some 5.4 billion Euros (77 %) had been spent by the end of 2010.

The underground remediation measures are near completion. Abandonment of the Königstein mine is scheduled for 2012. The Ronneburg and Pöhla mines were abandoned as early as 2000 and 2007, respectively.

Currently, underground development work is under way at two sites with the aim to facilitate targeted the mine water discharge:

- Dresden-Gittersee site: Development of the WISMUT gallery is under way to ensure the safe discharge of mine water via the historical *Tiefer Elbstollen* into the Elbe River, the first order receiving water. Until now gallery development progress via access ramp is 1 966 m (June 2011), equivalent to approx. 60% of the total length of 3 250 m. Completion of the WISMUT gallery is planned for 2013.
- Schlema site: At this site a by-pass adit (total length approximately 1 000 m) across the Schlema uranium mine is to be developed to replace a section of a historic adit which drains mine waters from the Schneeberg ore mine and passes through geomechanically unstable rock. Development of the adit will take from 2011 to 2013. Completion of all underground works at this site is slated for 2017.

Waste rock pile remediation has also made good progress. With the exception of waste rock piles #309 and #310, all inactive waste rock piles are remediated. At the Ronneburg site, relocation of the mine dumps was completed during the reporting period. The Lichtenberg open pit mine is backfilled. The degree of accomplishment is 91 % in mine dump excavation and relocation and 85 % in covering of the waste rock piles and the backfilled open pit.

Remediation of mine dump #371 at the Schlema site and of the Schüsselgrund dump at the Königstein site has made further progress in terms of regrading and covering. Operation of both heaps will include disposal of residues from the treatment of radioactively contaminated drainage and seepage waters which will continue for several decades to come. The final covering of the disposal section at mine dump #371, which represents some 5 % of the total footprint, will only be implemented at the conclusion of remediation and subsequent long-term tasks. Covering of the remaining construction sections at the Schüsselgrund dump which represent some 20 per cent of the total cover surface will be completed by 2026 and only resume after the termination of water treatment, currently expected to phase out by 2022.

During the period under review, remediation of the most important **plant areas** of WISMUT was completed: the Crossen plant area in 2008, the Seelingstädt area in 2010. These areas once were home to the largest uranium ore processing facilities in Europe. Conditions at the Seelingstädt site allowed the complete excavation of contaminated materials from the plant area and their disposal in the Culmitzsch tailings pond. Because of complicated hydrological and technological conditions, excavation at the Crossen site was limited to 412 000 m³ followed by the placement of uncontaminated soil material. With due regard to optimisation criteria, some of the contaminated underlying material was left in place and covered. Evidence was provided that the remaining residual contaminations would not cause intolerable environmental impacts. The contaminated excavated soil was shipped to the Helmsdorf tailings pond.

During the period under review, further progress has been achieved with regard to the remediation of **tailings management areas**. The figures in Table 1 below illustrate remediation progress and achievements during the period under review.

Table 1: Selected parameters on remedial progress: Figures taken from the Report for the Third Review Meeting (end of 2007) compared to the status by the end of 2010 (Report for the Fourth Review Meeting)

	End of 2007*		End of 2010**	
	absolute	relative[1)]	absolute	relative[1)]
Abandoned mine workings	1 450 km	99 %	1 463 km	99 %
Rehabilitated shafts/entrances	1 364 000 m³	97 %	1 386 000 m³	98 %
Backfilled mine workings	219 000 m³	95 %	229 881 m³	99 %
Relocation of material to industrial tailings ponds[2)]	7.8 Mio. m³	36 %	12.2 Mio. m³	49 %
Final covering of the industrial tailings ponds	1.8 Mio. m³	16 %	3.5 Mio. m³	32 %
Material from decommissioning of facilities	800 000 m³	89 %	957 000 m³	91 %
Remediated facility areas	920 ha	68 %	1 036 ha	72 %

1) Related to overall WISMUT remediation
2) Tailings management areas
* Long-term planning 2003
** Long-term planning 2007

The **flooding of the mines** still proves to be a highly complex issue. In Pöhla the natural water level was already reached in 1995 and in Dresden-Gittersee the flooding is almost complete. Controlled mine flooding at other sites involves intense mine water pumping and treatment. Due to the high total volume of water to be treated (> 1 000 m³/h during wet years) and the elevated pollutant concentration in the water treatment residues, considerable technical means and financial expenditures are required at the Schlema site.

At Ronneburg, the dynamics of flood water rise and the associated water emergences at the surface made it imperative to expand the capacity of the existing water treatment facility. Following completion of the reconstruction in 2011, the design capacity will be raised to 750 m³/h. Given the existing pollution potential at the Königstein mine where uranium ore was leached underground and awaiting regulatory approval and licencing, further flooding has been halted for the time being. During the period under review since the Third Review Meeting, WISMUT has increasingly focused on the modelling of potential environmental impacts caused by continued flooding of the Königstein mine, and has carried out pilot tests on in-situ immobilisation of pollutants including pertinent field trials in that mine. The conceptual preparations and implementation of the final flooding at the three above-mentioned sites are among the major challenges which WISMUT is facing in the coming reporting period.

3 Presentation of selected remediation projects und results

During the period under review, WISMUT has taken stock of achievements made at sites under remediation in Saxony. Such stock-taking is yet to be done with regard to sites located in Thuringia, however, such undertaking only makes sense when the remediation of the large tailings management areas at the Seelingstädt site is about to be completed.

Stock-taking for the sites located in Saxony arrived at the conclusion that, with only a few exceptions, there is compliance with the target set from a radiological point of view to fall well below the effective dose limit of 1 mSv/a caused by the legacies of uranium mining. These exceptions are a few exposure locations in Schlema which still continue to exhibit locally elevated radon concentrations and where further investigations and remedial measures are required.

The positive remediation results are corroborated by the findings of environmental monitoring, as exemplified by data on radon concentration at the toe of mine dump #66/20 (see Fig. 1 and Fig. 2).

Fig. 1: Remediation of mine dump #66/207 (Schlema site, Edelhofweg area) before and after remediation (Copyright: Wismut GmbH)

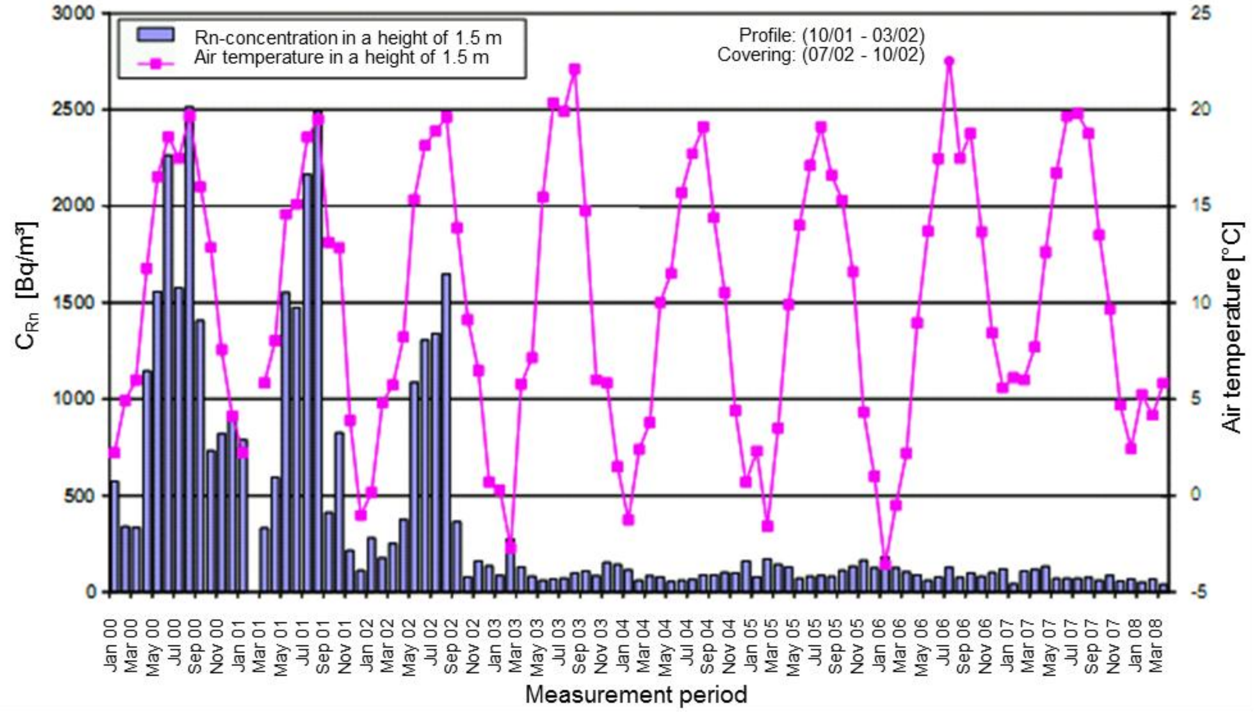

Fig. 2: Decline of radon concentration levels at the Edelhofweg area of mine dump #66/207

Fig. 2 shows the effect of waste rock pile regarding (winter 2002/2003) and covering (summer 2003) on radon concentration levels at the toe of the pile. Regarding of the waste rock pile resulted in flattening the slope and increasing air circulation in the vicinity of the pile close to a residential area. Not until after placement of a 1.5 m thick cover of inert material with sufficient radon retention capability, the convective air flow in the dump, induced by temperature fluctuations of the outside air, could be shut off. Since then radon exhalation rates and radon concentration have dropped to a low level and will remain stable in the long-term.

The reduction of discharges of uranium and other pollutants into receiving streams (Fig. 3) provides further evidence for the remediation-induced mitigation of environmental impacts caused by uranium mining legacies.

While at the beginning of the remediation in 1991, the controlled discharge of uranium into surface waters totalled some 27.5 Mg, discharge in 2010 was down to only 4.4 Mg. The same holds true for the drop in Ra-226 discharge. This decrease comes as the result of the operation of efficient water treatment facilities as well as of the on-going cover placement on waste rock piles and tailings management areas which gradually reduced pollutant discharge in leachate.

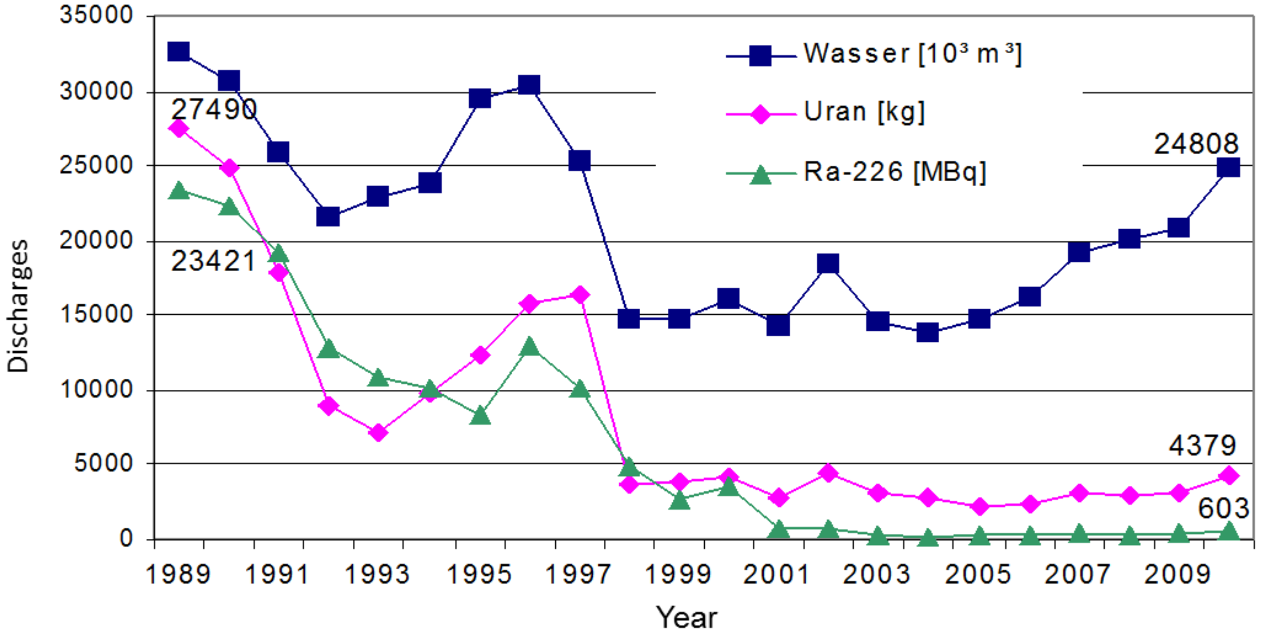

Fig. 3: Development of discharge of uranium and Ra-226 in surface waters

The remediation progress achieved since 1990 is optically visible, too. The following selected views of remediation projects depict the plant areas before and after remediation.

Fig. 4: Seelingstädt plant area before and after remediation (Copyright: Wismut GmbH)

Fig. 5: Crossen plant area before and after remediation (Copyright: Wismut GmbH)

Fig. 6: Blasting of the Rottwerndorf ore loading facility (Königstein site) and the remediated plant areas (Copyright: Wismut GmbH)

Fig. 7: Mine dump #38new (Schlema site) before and after remediation (Copyright: Wismut GmbH)

4 Long-term tasks and prospect

Categorisation of the long-term tasks and their scheduling was comprehensively detailed in the Report for the Third Review Meeting.

To date, the following long-term tasks have been identified:

I. Inspection, repair, maintenance and care of technical structures such as covers, etc.

II. Treatment of flooding waters and seepage.

III. Stability of mine workings.
IV. Environmental monitoring.
V. Mitigation of mining damage.
VI. Preservation and maintenance of the documentation of remediation.

During the period under review, WISMUT specified the last mentioned task as an additional long-term task in terms of long-term data management and defined the preservation and maintenance of the remedial know-how and expertise along the lines of “record management”.

Current efforts are focused on working out issues related to substance and technical options for the preservation of remedial know-how and expertise as well as on preparing pilot documents for the final documentation including a final evaluation of the remediation operations.

With respect to environmental impact monitoring, WISMUT is preparing the establishment of networks of key monitoring points which will allow long-term monitoring of system behaviour of remediated objects.

On the basis of a revaluation of the remediation programme in 2010, the required time frames as well as the required funding for the completion of the WISMUT’s remediation assignment were defined more precisely. According to this revaluation, the remaining physical works under the basic remediation programme (final covering of the Culmitzsch tailings management area, covering of the last mine dump at Königstein) shall be carried out after 2020. Current planning of long-term tasks covers the period until 2040. With regard to funding, it is considered that the new estimate of some 7 billion Euros may be adequate for the above-mentioned period.