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

**Report under the Joint Convention by the Government of the Federal Republic of Germany for the Second Review Meeting in May 2006**

Imprint

| | |
|---|---|
| Published by: | Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)<br>Public Relations Division<br>D – 11055 Berlin<br>E-Mail: service@bmu.bund.de<br>Internet: http://www.bmu.de |
| Editors: | Divison RS III 3<br>(Nuclear Waste Management, Nuclear Fuel Cycle) |
| Illustrations: | Titel: Getty Images (M. Dunning); Enercon / Block Design; Visum (K. Sawabe); zefa; Getty Images (C. Coleman) |
| Date: | September 2005 |
| First Print: | 100 copies |

## Table of Contents

**List of Abbreviations**

| | |
|---|---|
| AkEnd | *Arbeitskreis Auswahlverfahren Endlagerstandorte*<br>(Committee on a Selection Procedure for Repository Sites) |
| BAFA | *Bundesamt für Wirtschaft und Ausfuhrkontrolle*<br>(Federal Office of Economics and Export Control) |
| BfS | *Bundesamt für Strahlenschutz*<br>(Federal Office for Radiation Protection) |
| BGBl. | *Bundesgesetzblatt*<br>(Federal Law Gazette) |
| BMBF | *Bundesministerium für Bildung und Forschung*<br>(Federal Ministry of Education, Science, Research and Technology) |
| BMU | *Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit*<br>(Federal Ministry for the Environment, Nature Conservation and Nuclear Safety) |
| BNFL | British Nuclear Fuels Ltd. |
| BWR | Boiling Water Reactor |
| CEA | Commissariat à l'Energie Atomique (Paris) |
| COGEMA | Compagnie Générale des Matières Nucléaires |
| DBE | *Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH*<br>(German Service Company for the Construction and Operation of Waste Repositories) |
| GDR | German Democratic Republic |
| DESY | *Deutsches Elektronen-Synchrotron* |
| DIN | *Deutsches Institut für Normung e. V.*<br>(German Institute for Standardisation) |
| EAN | European Article Numbering |
| EBA | Eisenbahn-Bundesamt<br>(Federal Office for Railways) |
| EIA | Environmental Impact Assessment |
| ERAM | *Endlager für radioaktive Abfälle Morsleben*<br>(Repository for Radioactive Waste Morsleben) |
| EURATOM | European Atomic Energy Community |
| EUROCHEMIC | European Company for the Chemical Processing of Irradiated Fuels |
| EU | European Union |
| EVU | *Energieversorgungsunternehmen*<br>(Electric Power Utility) |
| FZJ | *Forschungszentrum Jülich GmbH*<br>(Research Centre Jülich GmbH) |
| FZK | *Forschungszentrum Karlsruhe GmbH*<br>(Research Centre Karlsruhe GmbH) |
| GKSS | *Forschungszentrum Geesthacht GmbH (formerly: Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt mbH)*<br>(Research Centre Geesthacht GmbH) |
| GNS | *Gesellschaft für Nuklear-Service mbH* |
| GSI | *Gesellschaft für Schwerionenforschung mbH* |
| GSF | *Forschungszentrum für Umwelt und Gesundheit GmbH (formerly: Gesellschaft für Strahlenforschung)*<br>(Research Centre for Environment and Health) |
| HAW | High-Active Waste |
| HAWC | High-Active Waste Concentrate |
| HDB | *Hauptabteilung Dekontaminationsbetriebe des Forschungszentrums Karlsruhe*<br>(Central Decontamination Department of the Karlsruhe Research Centre) |

| | |
|---|---|
| HEU | Highly Enriched Uranium |
| HGF | *Hermann von Helmholtz-Gemeinschaft Deutscher Forschungszentren* |
| HMI | *Hahn-Meitner-Institut für Kernforschung* |
| HRQ | *Hochradioaktive Quellen*<br>(High-Active Sources) |
| HTR | High Temperature Reactor |
| IAEA/*IAEO* | International Atomic Energy Agency/*Internationale Atomenergie Organisation* |
| ICRP | International Commission on Radiological Protection |
| IEC | International Electrotechnical Commission |
| IMIS | *Integrierte Mess- und Informationssystem zur Überwachung der Umweltradioaktivität*<br>(Integrated Measurement and Information System for Monitoring Environmental Radioactivity) |
| INES | International Nuclear Event Scale |
| ISO | International Organization for Standardization |
| ITU | *Europäisches Institut für Transurane*<br>(European Institute for Transuranic Elements) |
| KFA | *Kernforschungsanlage Jülich* (now FZJ) |
| KfK | *Kernforschungszentrum Karlsruhe* (now FZK) |
| KTA | *Kerntechnischer Ausschuss*<br>(Nuclear Safety Standards Commission) |
| KWU | *Kraftwerk Union AG* |
| LAA | *Länderausschuß für Atomkernenergie*<br>(Länder (Federal States) Committee on Nuclear Power) |
| LAFAB | *Länderausschuß für Atomkernenergie – Fachausschuß Brennstoffkreislauf*<br>(Länder (Federal States) Committee on Nuclear Power – Specialised Fuel Cycle Committee) |
| LBA | *Luftfahrtbundesamt*<br>(Federal Civil Aviation Authority) |
| LAW | Low Active Waste |
| LWR | Light Water Reactor |
| MAW | Medium Active Waste |
| NEA | Nuclear Energy Agency |
| NORM | Naturally Occurring Radioactive Material |
| NPP | Nuclear Power Plant |
| OECD | Organisation for Economic Co-operation and Development |
| OJ EC | Official Journal of the European Communities |
| PAE | *Projektgruppe Andere Entsorgungstechniken des Forschungszentrum Karlsruhe*<br>(Project Group for Alternative Waste Management Techniques, Karlsruhe Research Centre) |
| PWR | Pressurized water reactor |
| RSK | *Reaktorsicherheitskommission*<br>(Reactor Safety Commission) |
| SKB | Svensk Kärnbränslehantering AB (Swedish Nuclear Fuel and Waste Management Co) |
| SSK | *Strahlenschutzkommission*<br>(Commission on Radiological Protection) |
| TBL | *Transportbehälterlager*<br>(Transport Cask Storage Facility) |
| TENORM | Technologically-Enhanced Naturally Occurring Radioactive Material |
| UKAEA | United Kingdom Atomic Energy Agency |
| VKTA | *Verein für Kernverfahrenstechnik und Analytik Rossendorf e. V.* |
| WWER | Water Cooled and Water Moderated Energy Reactor (Soviet design) |

## Section A. Introduction

### (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. In submitting this report, the Federal Republic of Germany is demonstrating its compliance with the Joint Convention and ensuring 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 still a need for future action in order to maintain the required high standards of safety and ensure disposal.

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

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

The report contains a list of nuclear facilities currently in operation as defined by this Convention, including an overview of the safety-relevant design characteristics of those facilities, classified according to their management of spent fuel or radioactive waste, together with a list of decommissioned and dismantled facilities, 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 second German national report does not merely include modifications of the first report but provides updated information to form a comprehensive overall description of the current status. Wherever the report goes into more detail on certain Articles as a result of the questions posed on the first report and of the findings of the First Review Meeting and where major amendments have been made due to the developments, this is marked in the margin.

The information provided by the report applied as at the deadline of 30 April 2005 unless expressly specified otherwise.

In the view of the German Federal Government, the contaminated industrial sites of Wismut AG that were taken over from the former GDR are not subject to the reporting obligations according to Article 3, Paragraph 2. Still, the ecological restoration activities of Wismut GmbH are presented in a separately attached report.

### (2) Historical Development

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

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

in Jülich (Kernforschungsanlage Jülich - KFA)

in Geesthacht (Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt GKSS),

1959 in Berlin (Hahn-Meitner-Institut für Kernforschung - HMI) and

in Hamburg (Deutsches Elektronen-Synchrotron - DESY);

1969 in Darmstadt (Gesellschaft für Schwerionenforschung - GSI).

Many universities were equipped with research reactors. The FRM research reactor in Garching was the first to go critical on 31 October 1957, and the most recent licence was granted in 2004, this time for the FRM II research reactor at the same site.

In 1957, the first German nuclear power plant, the 15 MWe experimental nuclear power plant (VAK) in Kahl, was ordered from General Electric and AEG, and became operational in 1960. Between 1965 and 1970, this was followed by further orders for power reactors with 250-350 MWe and 600-700 MWe respectively.

In the years that followed, larger power reactors (PWR and BWR) were built by the company Kraftwerk Union (KWU) with a capacity of 1300 MWe, the last of which commenced operation in 1988. Since then, nuclear energy has accounted for just over 30 % of electricity production in Germany. The power reactors are operated with enriched uranium (up to 6 %) and MOX fuel assemblies containing recycled plutonium originating from the reprocessing of German fuel assemblies in France and the United Kingdom.

Reactors with a lower output from the early years of nuclear power use have since been switched off, and are in varying stages of decommissioning. Two of them have been dismantled and the land recultivated. Three larger power reactors have likewise been deactivated. Dismantling at Würgassen is far advanced, whilst in the case of Mülheim-Kärlich it has been started; as to Stade, the first decommissioning licence is expected to be granted shortly (for details cf. Table L-11). The Obrigheim nuclear power plant was closed down on 11 May 2005; an application for decommissioning had been made on 21 December 2004.

In the 1950s, West Germany likewise began to independently develop reactors, with close collaboration between the nuclear research centres and industry. This led to the construction of a number of experimental reactors. Worth mentioning in this connection are the order placed in 1958 with BBK/BBC for the experimental 15 MWe *Arbeitsgemeinschaft Versuchsreaktor* (AVR) high-temperature pebble-bed reactor at the Jülich Nuclear Research Centre, and the order placed in 1961 with Siemens for the 52 MW multi-purpose research reactor (MZFR), a heavy water PWR. In the late Sixties, development work began on a fast breeder at the Karlsruhe Nuclear Research Centre. This was later followed by the construction of two prototypes, a high-temperature pebble-bed reactor on the basis of thorium (Thorium High Temperature Reactor – THTR-300) and a fast breeder (SNR-300), each with a capacity of 300 MWe. The THTR was shut down after six years of operation ( 1983-1989 ) and is currently securely encapsulated, whilst the SNR was completed but never loaded with fuel assemblies. The SNR fuel assemblies that had been produced already are being converted in France into MOX fuel assemblies for light water reactors.

In 1955, the GDR began developing a 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. The first commercial reactor – a 70-MWe pressurised water reactor of Soviet design – was built in Rheinsberg and reached criticality in 1966. Between 1973 and 1989, five pressurised water reactors, four of the Soviet type WWER-440/230 and one of type WWER-440/W-213, started operation in Greifswald.

During the course of German reunification, all six of these reactors were shut down and are now being dismantled. At the same time, the construction of five further WWER reactors at Greifswald and Stendal was discontinued.

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

As early as in the 1950s, nuclear waste management was included in all planning activities. A Memorandum of the German Atomic Commission, an advisory committee to the former Ministry for Atomic Issues, of 9 December 1957 already pointed out the need for comprehensive development in the field of waste management. The importance of safe radioactive waste management was emphasised by the legislator in an amendment of the Atomic Energy Act in 1976 which included the new § 9a that demanded the proper disposal of radioactive waste.

Regarding the commercial use of nuclear power in Germany, in addition to power reactors, other nuclear facilities correspondingly also began to emerge; these were designed to ensure the fuel cycle and the safe disposal of all waste resulting from this use.

In the Seventies, the German utility companies formulated plans 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” (*Entsorgungszentrum*). This disposal centre, consisting of a reprocessing plant, fuel fabrication plants for uranium and MOX fuel rods, 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. Plans for the centre, with the exception of the repository project, were later shelved in 1979 following political intervention by the state government of Lower Saxony, whereupon the utilities turned instead to plans for a scaled-down project which would be confined to reprocessing and MOX-fuel fabrication at the site of Wackersdorf in Bavaria. In 1989, the utilities subsequently resolved to abandon this project, and the on-going licensing procedure was cancelled. From then onwards, the utilities turned their attention instead to reprocessing abroad.

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

The pilot reprocessing plant at Karlsruhe (WAK) was decommissioned in 1990 and is in the process of being dismantled. There are plans to vitrify the highly radioactive solutions of fission products still remaining at this plant in order to prepare them for disposal. A corresponding plant for this purpose has been built but is not yet in operation. A number of facilities are currently operational for the interim storage of spent fuels as well as the treatment, conditioning and interim storage of radioactive waste. The licensing procedure for the pilot conditioning plant (PKA) in Gorleben, which was designed for the conditioning of spent fuel for direct disposal, was completed in December 2000 with the granting of the third partial construction licence which refers to the repair of defective casks for spent fuel assemblies.

Development work in the field of repositories began with the installation of the ASSE research mine in a salt dome, where low- and medium-level radioactive waste was disposed of on an experimental basis until the end of 1978. In the former GDR, the Morsleben repository was available for the disposal of low and medium-level radioactive waste; following reunification, this repository was used for the emplacement of low- and medium-level radioactive waste from all over Germany up until September 1998.

In 1982, an application was submitted to store non-heat generating waste at the Konrad mine, which is a former ore mine. A licence to this effect was granted in May 2002. A claim has meanwhile been lodged against this licence. Exploration works in the salt dome at the site of Gorleben commenced in 1986, aimed at establishing whether this salt dome is suitable for the disposal of radioactive waste, including high-level waste. The underground exploration works in the Gorleben mine were interrupted in the year 2000 for a minimum of 3 years, and a maximum of 10 years.

In 1946, an initially purely Soviet joint-stock company began mining uranium ore on the territory of what was later to become the German Democratic Republic (GDR). From 1954 onwards, this was continued by the Soviet-German Wismut joint-stock company. The mining of uranium ore was discontinued at the end of 1990 following German reunification. The uranium ore mining activities have caused considerable environmental damage which the state-owned Wismut GmbH has been remediating for the last 15 years. 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 separately attached report.

## (3) Political Development

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

Following the euphoria of the Fifties and Sixties, scepticism towards nuclear power began to grow in Germany. Increasing numbers of citizens became opposed to the risks of atomic energy, and in particular the further expansion of nuclear power plants. Names such as Wyhl/Brokdorf (nuclear power plants), Gorleben (waste management centre), Wackersdorf (reprocessing) and Kalkar (fast breeder) have become synonymous with this protest movement. By the time of the accident in Harrisburg in 1979 and finally the Chernobyl disaster in 1986, it had become clear that the risks of nuclear power are not merely theoretical. These events strengthened opposition to the use of nuclear power; and with no further major projects in the pipeline, resistance was directed instead primarily against the transportation of nuclear materials, and particularly the interim storage facilities at Ahaus and Gorleben.

Mindful of the fact that both human life and public health are protected under the German constitution, the Federal Republic of Germany will phase out in a carefully coordinated process the use of nuclear energy for the commercial generation of electricity due to the associated risks. The unresolved issue of the disposal of high-active waste is seen by the Federal Republic of Germany as a further reason for a nuclear phase-out. This is demonstrated by the fact that so far there is no corresponding repository in operation world-wide. The protection of life, physical integrity, public health and of the natural resources needed to sustain life demands that radioactive waste must be stored safely in perpetuity in such a way that it is separated from the biosphere. It is only by such safe storage that it can be guaranteed that the radioactive waste will not be an inadmissible burden on future generations. With this in mind, the phase-out of nuclear power also aims to at least limit the production of further radioactive waste from facilities dedicated to the commercial use of nuclear power so that the risk of such a burden is reduced.

The Federal Republic of Germany estimates the radiation risk, as determined on the basis of the results of a re-evaluation of empirical data by the International Radiation Protection Commission, to be higher than was originally presumed at the time of the licensing of the German nuclear facilities in accordance with the Atomic Energy Act of 1959. Allowance was made for these re-evaluations in the 2001 amendment to the Radiation Protection Ordinance.

With the agreement of 14 June 2000 [BUN 00] between the Federal Government and the power utilities and signed by the Federal Government and EnBW, E.ON, HEW and RWE on 11 June 2001, in spite of the prevailing differences of opinion on the use of nuclear power, the German power industry has demonstrated that it respects the Federal Government's decision to phase out the production of electricity from nuclear energy in a carefully coordinated process and to work towards implementation of the new energy policy. Although this agreement is not legally binding, it contains measures that were mutually agreed as being part of the scope of this agreement and which have been implemented by the parties involved.

With the entry into force of the Act on the Phase-out of the Use of Nuclear Energy for the Commercial Production of Electricity in a Carefully Coordinated Process of 22 April 2002 [1A-2], the essential elements of the agreement were turned into law. For example, the Act limits the regular operating lifetimes of the nuclear power plants to 32 years from the respective dates of commissioning. Another of its purposes is to limit the amount of radioactive waste arising.

Further items of the agreement which became legal with the amendment of the Atomic Energy Act and which are relevant to the Joint Convention are the following:

- Reprocessing will be discontinued and replaced by the direct disposal of the spent fuel assemblies.
- The delivery of spent fuel assemblies to La Hague and Sellafield for reprocessing will be terminated by the middle of 2005. From then on, the spent fuel assemblies will have to be put in interim storage on-site at the plants until the conditions have been created to put them in final storage. (Thanks to this move, and by setting up local interim storage facilities at the sites of the German nuclear power plants for the existing and the remaining spent fuel assemblies that will arise until the time of decommissioning, the number of nuclear transports will considerably be reduced. In future, this number will be reduced to up to one third. Of all the interim storage facilities that have been applied for so far, some are already in operation; the rest have been granted their construction licences and are presently being erected.
- A precondition for reprocessing is that proof must be submitted of the non-hazardous utilisation of separated nuclear fuel and the disposal of returned reprocessing waste in a carefully coordinated process. Requirements governing the form and content of this proof are specified by a new provision in the aforementioned amendment of the Atomic Energy Act.

Major key items of this agreement that were not turned into law but which apply to the scope of the agreement have been realised:

- The licensing procedure for the pilot plant for the conditioning of spent fuel assemblies has been completed. The licence was granted in December 2000 and is restricted to the repair of defective spent-fuel assembly casks.
- The moratorium period for the Gorleben salt dome commenced on 1 October 2000. The mine will be kept open for the period of the moratorium, with a legal provision, the so-called Gorleben Development Freeze Ordinance (Gorleben-Veränderungssperren-Verordnung - GorlebenVspV), ensuring that the site is preserved and made safe in its current state. This Ordinance entered into force with its publication in the Federal Bulletin on 16 August 2005. The Federal Government will use this interruption to clarify safety-related and conceptual issues concerning final disposal.

- The plan approval procedure for the Konrad repository was completed and a plan approval decision adopted on 22 May 2002. However, the decision is not yet legally valid since objections have been filed.

It is essential to ensure the safe operation of the nuclear power plants during the remainder of their operating lives, as well as that of facilities for the processing of spent fuel assemblies and radioactive waste. To this end, an efficient and well-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 the Federal Republic of Germany, the Basic Law (GG) [GG 49] sets forth the principles of a democratic social order, namely the government's responsibility to protect life and health and natural resources needed to sustain life, the separation of powers, the independence of licensing and supervisory authorities, and the supervision of administrative actions by independent courts. The legislation, administrative authorities and jurisdiction created specifically for the peaceful use of nuclear energy provide the framework of a system which safeguards the protection of life, health and property of those directly employed by the industry, and the general public, from the hazards of nuclear energy and the damaging effects of ionising radiation, as well as ensuring the regulation and supervision of safety during the construction and operation of nuclear installations. In accordance with the statutory requirements in the field of nuclear technology, ensuring safety is the highest priority. By applying the best available technology as a key guiding principle, measures are taken to ensure that internationally accepted safety standards as specified, for example, in the ”Safety Fundamentals” of the IAEA [IAEA 95], [IAEA 96F] are taken into account. One principal objective of the German Federal Government’s safety policy in the field of nuclear energy was, and still is , that the operators of nuclear facilities should also develop a high safety culture within their own field of responsibility.

## Section B. Policies and Practices

### Article 32 (Reporting), Paragraph 1

*Article 32*

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.*

The report contains information pertaining to the situation for the safe management of spent fuel assemblies in Germany. In Germany, the reprocessing of fuel assemblies would be classified under "management" within the meaning of this Convention. However, as Germany delivered spent fuel assemblies to France and the United Kingdom for reprocessing until mid-2005, no report will be given here on the reprocessing of German fuel assemblies. There are no fuel assemblies used by the military sector in Germany, and hence there is also no need to report on this aspect.

The report also contains information regarding the situation for the safe management of radioactive waste in Germany in the scope of this Convention. NORM and TENORM waste (cf. comments on Article 3 2.) are 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 surveillance.

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

*Article 32 1.*

*For each Contracting Party the report shall also address its:*

*Article 32 1.*

*(i) spent fuel management policy;*

Germany's policy on the management of spent fuel has undergone a number of changes. Until 1994, the Atomic Energy Act included the requirement of reusing the fissile material in the spent fuel assemblies. This requirement changed with the amendment of the Act in 1994, and the operators of nuclear power stations then had the option of either reuse by means of reprocessing, or else direct disposal.

As of 1 July 2005, delivery for the purposes of reprocessing will be prohibited in accordance with an amendment to the Atomic Energy Act (AtG) to this effect of 22 April 2002 [1A-2], and only direct disposal of the spent fuel assemblies then existing in Germany will be possible. By 30 June 2005, most of the spent fuel assemblies had been shipped to said facilities by the nuclear power plant operators; the last spent fuel assemblies from the Stade nuclear power plant were dispatched for reprocessing before the end-of-June-2005 deadline.

For those spent fuel assemblies disposed of by way of reprocessing, proof of reuse must be kept of the recycled plutonium separated during reprocessing. This is designed to ensure that throughout the remaining residual operating lives of the nuclear power plants, all separated plutonium is processed in the fabrication of MOX fuel assemblies and thus re-used.

As there is as yet no repository available for the remaining spent fuel assemblies, they will be stored intermediately at the site where they were created until such time as the repository is commissioned, in order to avoid the transportation of spent fuel and help spread the burden; corresponding storage facilities exist as needed or are being erected.

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

The Federal Government is aiming to establish a repository in deep geological formations for the disposal of all kinds of waste, including spent fuel assemblies, by the year 2030. Until the year 2000, the Gorleben salt dome was also explored with regard to its suitability as a repository, especially for heat-generating waste. Since then, a moratorium has been in place on the exploration, running for between 3 and 10 years, depending on the clarification of safety-related and conceptual issues regarding final storage. This clarification process has not yet been concluded. The moratorium on Gorleben does not mean that the salt dome has been abandoned as a possible repository site, also for the disposal of spent fuel assemblies.

*Article 32 1.*

*(ii) 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 reuse of all plutonium generated, generally by means of its re-use as MOX in the reactor, and the safe storage of all uranium.

All other types of fuel assemblies remaining in Germany, and those which will continue to be generated, will be stored in interim storage facilities until their final transportation into a repository. In line with statutory requirements this is done in interim storage facilities that have been or are yet to be constructed at the sites of the nuclear power plants, which will be reserved solely for spent fuel arising at that particular site. With the exception of KWO, the spent fuel is stored dry in casks licensed for transport and storage. Spent fuel assemblies from decommissioned power reactors of Soviet design in Greifswald and Rheinsberg are likewise stored dry in casks at a central storage facility in Greifswald.

Only for exceptional cases, if interim storage at the site of the nuclear power plants is not possible on technical grounds, are two central storage facilities operational and on stand-by at Ahaus and Gorleben.

*Article 32 1.*

*(iii) 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. The Federal Government is required to provide the resources for disposal.

Additionally, it is a legal requirement that all stages in the treatment of radioactive waste prior to its disposal are subject to the “polluter pays” principle.

In accordance with this principle, the state obligates the creators of waste by law to ensure the controlled and safe management of radioactive waste arising during the operation and decommissioning of nuclear facilities (such as nuclear power plants and research centres). As such, they operate 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 may be deposited in State collecting facilities provided by the *Länder* (Federal states). The Federal Government is obliged to accept the waste from these storage facilities for final disposal if it cannot be released once the radioactivity has decayed.

In line with its objective to dispose of this waste in deep geological formations, too, the Federal Government is not pursuing any plans for near-surface repositories. In May 2002, the licensing procedure for the Konrad repository to take in this kind of waste was concluded, but pending legal proceedings are currently delaying emplacement operations.

*Article 32 1.*

*(iv) 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 prior to entering the repository.

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

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

Both centralised and decentralised storage facilities are available for the interim storage of radioactive waste with negligible heat generation from nuclear power plants and the nuclear industry. For waste arising from the use and handling of radioisotopes in research, industry and medicine (cf. explanatory comments on Article 32 1. (iii)), State collection facilities operated by the *Länder* (Federal States) are available for interim storage, whilst central storage facilities are available for heat generating radioactive waste. The existing licences allow the longer-term storage – for up to 40 years – of the radioactive waste in the decentralised and centralised interim storage facilities.

Within the scope of product control, the compliance of the packages with the requirements set out in the acceptance criteria of the repository will be reviewed. At present, the acceptance criteria of the Konrad repository [BfS 95] are particularly decisive; non-site-dependent acceptance criteria are currently under development. The product control measures concern both existing conditioned radioactive waste, as well as waste due to be conditioned in the future. They are designed in such a way as to ensure reliable detection of any packages which fail to meet the specifications.

Between 1971 and 1998, low- and medium-level radioactive waste from nuclear facilities 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, and a concept is currently under development to fill and seal this repository. There are also two further repository projects, Konrad and Gorleben. An appeal has been launched against the plan approval notice for Gorleben issued in May 2002; meanwhile, the underground explorations at the Gorleben repository mine have been interrupted whilst the conceptual and safety related issues are clarified.

*Article 32 1.*

*(v) criteria used to define and categorize radioactive waste.*

Radioactive residues are produced during the operation of nuclear facilities and installations, as well 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 reused and which must therefore be disposed of in a controlled way (cf. term definitions in section 2 of the Atomic Energy Act (AtG)and DIN 25401 [DIN 25401], regulations governing recycling and disposal in section 9a of the Atomic Energy Act, and section 29 of the Radiation Protection Ordinance (StrlSchV)). 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 Section 29 of the 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 German repository concept is pivotal to the criteria used to define and categorize radioactive waste. In the Federal Republic of Germany, the intention is that all types of radioactive waste should be stored in deep geological formations. This applies to waste from reprocessing of spent fuel assemblies from German nuclear power plants at facilities in other European countries, as well as to waste from the operation and decommissioning and/or dismantling of commercially operated nuclear facilities, together with waste originating from the use of radioisotopes in research, trade, industry and medicine.

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

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

- Heat-generating radioactive waste and
- Radioactive waste with negligible heat generation

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

This basic subdivision into heat-generating waste and waste with negligible heat generation was implemented with particular regard for repository-relevant aspects; it also applies when the waste packages for disposal are stored in a long-term surface interim storage facility prior to transportation into a repository. This waste categorisation 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 also compatible with the IAEA proposal for qualitative categorisation [IAEA 95] which additionally permits a further subdivision into short-lived and long-lived waste, thus allowing waste to be assigned to either "near-surface repositories" or "underground repositories".

Examples of heat-generating radioactive wastes include the fission product concentrate, shells, structural components and feed sludge from the reprocessing of spent fuel assemblies, and the fuel assemblies themselves if there are no plans to reprocess them but instead to dispose of them directly as radioactive waste. Radioactive waste with negligible heat generation encompasses all other types of waste such as metals and non-metals, filters and filter aids, readily and poorly combustible materials, biological waste and waste water, sludges/suspensions as well as oils, solvents or emulsions.

The term "radioactive waste with negligible heat generation" was quantified within the scope of the planning work for the Konrad repository project. According to the plan approval decision dated 22 May 2002, there are plans to dispose of low-level waste and radioactive waste from the decommissioning of nuclear facilities in the mine openings of the Konrad repository. Initially, implementation of the plan meant that the prevailing temperature conditions underground would only be influenced to a negligible extent by the waste packages stored there. Eventually, this led to the quantitative stipulation that the increase in temperature at the wall of the disposal chamber caused by decay heat from the radionuclides contained in the waste packages must not exceed 3 Kelvin on average. This value is roughly equivalent to the temperature difference which occurs with a difference in depth of 100 m in the natural temperature environment, and is low compared with the change of temperature caused by ventilation.

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 producer groups. Canisters, cast-iron containers, concrete containers, drums or box-shaped containers are predominantly used for packaging radioactive waste, whilst glass and cement/concrete are widely used for the purposes of immobilisation. Regarding waste type, it would seem appropriate to use a standardised nomenclature (cf. Annex X of the Radiation Protection Ordinance (StrlSchV)). A more precise grouping can be achieved by further subdividing or supplementing this rough categorisation. This categorisation scheme allows the description of radioactive waste to be systematised in a way which fulfils the requirements for proper registration and description of all existing waste and waste arising in the foreseeable future.

On this basis, further elaboration, including a site-specific safety assessment for a repository in deep geological formations, eventually leads to facility-related waste acceptance requirements, stipulating quantitative requirements governing radioactive waste which is intended for disposal. The "Requirements Governing the Acceptance of Radioactive Wastes for Disposal" (*Endlagerungsbedingungen*, last edited: December 1995, Konrad Mine) [BfS 95] is one such example. These requirements specify the final description or categorisation of waste from a repository-specific point of view.

## Section C. Scope of Application

### Article 3 (Scope of application)

*Article 3*

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.*

The safety of spent fuel management within the meaning of this Article is applicable to all spent fuel from German nuclear power plants and research reactors which is intermediately stored with the intention of disposal. Those German fuel assemblies which were delivered to France or the United Kingdom for reprocessing do not fall within the scope of this Article, and are therefore not subject to reporting here. Reprocessing at the reprocessing plant in Karlsruhe was discontinued in 1990; the plant has been shut down and is currently being dismantled. There were aspirations to construct a new reprocessing plant, but these have never been implemented. The amendment of the Atomic Energy Act of the year 2002 stipulates that plants for reprocessing must no longer be constructed or operated.

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

*Article 3*

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.*

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

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

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

**Practices**

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

**Work Activities**

Work activities refer to actions involving materials which, although they contain naturally occurring radionuclides, are not used for their radioactive properties. Examples include the use of building materials containing radionuclides from the U 238, U 235, and Th 232 decay chains, as well as the nuclide K 40, excavated materials from mining activities, fly ashes from combustion processes, residues from the flue-gas purification of coal-fired power plants etc.

As until now no radioactive wastes in the sense of this Convention have originated from work activities, a short overview is given in the following.

**Overview**

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

According to section 97 para. 1, anyone engaged or permitting engagement on his own responsibility in work activities where residues requiring surveillance accumulate and where the utilization or disposal thereof may cause the effective dose reference figure 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 section 97 para. 2 in connection with Appendix XII part A. The catalogue of residues which have to be taken into account is given in Appendix XII part A and lists application areas and branches from which residues may arise which may in principal lead to exceeding the 1 mSv/a dose criterion. The list includes the following materials:

1. Sludge and sediments from the recovery of oil and natural gas;
2. Unconditioned phosphoric plasters, sludge from their preparation as well as dust and cinder from the processing of raw phosphate (phosphorite);
3. a) country rock, sludge, sand, cinder and dust
    - from the extraction and preparation of bauxite, columbite, pyrochlore, microlyth, euxenite, copper shale, tin, rare earths and uranium ores,
    - from the processing of concentrates and residues that occur with the extraction and preparation of these ores and minerals, as well 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 section 97 are also

a) materials in accordance with the subparas. 1 ff., when the occurrence of these materials is deliberately produced,

b) castings from the materials specified in subparas. 1 ff., as well as

c) excavated or cleared ground and demolition waste from the dismantling of buildings or other structures when these contain residues in accordance with the subparas. 1 ff. and are removed in accordance with section 101 after completion of the work activities or in accordance with section 118, para. 5 or from properties.

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

**Release of Residues 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, they do not require surveillance. If the surveillance limits are exceeded, but if it could be demonstrated in a case specific evaluation according to section 98 para. 1 that the 1 mSv/a dose criterion is not exceeded, the competent authorities of the respective Federal State may release the residues from surveillance. The criteria listed in Appendix XII part C can be applied in this procedure.

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

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

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

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

**Experience from Application of the Regulations**
Compliance with the surveillance limits or the dose criterion with respect to the residues has been verified for a large number of companies using NORM on the basis of the regulations described

above. Various material streams have been investigated. In all cases which have been dealt with so far it was found that the surveillance limits were not exceeded or that compliance with the dose criterion can be demonstrated on the basis of case specific evaluations. No handover of residues which had to remain under surveillance to an institution taking care of the long-term storage of those residues has yet become necessary.

*Article 3*

*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.*

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

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

## Section D. <u>Inventories and Lists</u>

### Article 32 (Reporting), Paragraph 2

| |
|---|
| *Article 32* |
| *2. This report shall also include:* |

| |
|---|
| *Article 32 2.* |
| *(i) a list of the spent fuel management facilities subject to this Convention, their location, main purpose and essential features;* |

An overview of spent fuel management facilities can be found in the following Table D-1. More detailed information on existing and planned facilities can be found in Annex L-(a). These overviews also contain 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, including temporary storage facilities (so-called *Interimslager*),
- the interim storage facilities at Greifswald (ZAB, ZLN) for spent fuel from the nuclear power plants at Rheinsberg and Greifswald, and the storage facility at Jülich for spent fuel from the high-temperature reactor AVR,
- the central interim storage facilities at Gorleben (TBL-G) and Ahaus (BZA), and
- the pilot conditioning plant at Gorleben (PKA).

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

**Cooling Ponds within the Reactor Buildings**
The spent fuel assemblies unloaded from the reactor core are first placed in cooling ponds within the reactor building. These pools allow the required subsidence in activity and heat generation until the fuel is placed in a storage container for interim storage, and provides the operator with sufficient flexibility to operate the plant. The additional wet storage facility outside the reactor building at Obrigheim is an exceptional case. As this facility, like the cooling ponds inside the reactor buildings, is considered part of the power plant operation from a licensing point of view, it will not be considered in any further detail for the purposes of this report. It is, however, included in Table D-1 and Table L-1 for the sake of completeness.

**Onsite Interim Storage Facilities**
With regard to direct disposal, a remaining period of several decades still needs to be bridged, depending on the availability of a repository and the length of time required for heat generation to subside until disposal. The Federal Government's concept envisages that from 1 July 2005 onwards and without exception, spent fuel assemblies should be placed in interim storage at the reactor sites where they are generated, and should remain there until duly conditioned and disposed of in a repository. Interim storage at the site means that the number of fuel assembly transportations will be reduced.

By the end of 2003, nuclear licenses had granted for decentralised interim storage facilities for spent fuel assemblies at twelve sites. These are either under construction or already complete.

They are designed as dry storage facilities in which transport and storage containers loaded with spent fuel assemblies are emplaced. Various different types of interim storage facility design have been licensed (cf. Table L-4). They are cooled by passive air convection which removes the heat from the containers without any active technical systems. The leak-proof and accident-resistant containers 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 earthquakes, explosions and aircraft crashes, is ensured by the thick walls of the containers. It was demonstrated and confirmed in the licensing procedure that the containers are suitable for at least 40 years of storage; the licences limit the storage period correspondingly. Due to the planned date for the availability of a repository around the year 2030, the question of prolonging the storage period is immaterial.

The Stade nuclear power plant withdrew its application for the storage of spent fuel assemblies according to Section 6 of the Atomic Energy Act (AtG) as the reactor was finally closed down in 2003. All fuel assemblies were shipped for reprocessing to France. At the Obrigheim nuclear power plant, an increase of the wet storage capacity was licensed in 1998. The fuel assemblies remaining in the plant after its closure in May 2005 will be put in the external wet interim storage facility for the time being. All nuclear power plants currently in operation will have on-site dry interim storage facilities in the future. If construction proceeds to schedule, all on-site interim storage facilities are expected to be commissioned by 2006.

**Temporary storage facilities**

As a transitional solution until the on-site storage facilities are complete, and in order to avoid any disposal shortfalls, four nuclear power plant operators (Biblis, Krümmel, Neckarwestheim, Philippsburg) have been granted licences for such temporary storage facilities (so-called *Interimslager*). These installations have a capacity of up to 28 storage positions with a mobile concrete enclosure for each container. The intention is that the containers will be transferred to the respective on-site storage facility within a limited period of time. The containers in the temporary storage facilities are likewise cooled by passive air convection. The containers, combined with the concrete enclosures, ensure compliance with the admissible dose limits stipulated by the Radiation Protection Ordinance (StrlSchV) [1A-8]. Containers have already been emplaced in all four facilities.

**Gorleben and Ahaus**

Central storage facilities containing fuel assemblies from various German nuclear power plants have been licensed at Gorleben (Figure D–1) and Ahaus. The facilities are designed as dry storage facilities. Here too, the types of containers for spent fuel assemblies are in part identical with those already mentioned above in conjunction with on-site storage facilities. The Ahaus facility is additionally licensed for HTR and MTR fuel assembly containers (Figure D–2). The Gorleben facility is additionally licensed for canisters holding vitrified HAW.

**Interim Storage Facilities at Greifswald and Jülich**

There also exist storage facilities at Greifswald/Rubenow and Jülich. As specified, the dry “Interim Storage Facility North” (ZLN) has only accepted fuel assemblies from the Soviet-type reactors at Rheinsberg and Greifswald. Of the spent fuel assemblies from the reactors at Greifswald, a few remaining ones are still being stored in the nearby wet storage facility (ZAB). During 2006, these will be removed and put in interim storage at ZLN.

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

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

Figure D–2: CASTOR-THTR containers in the Ahaus interim storage facility (Copyright: GNS)

**Pilot Conditioning Plant**
The German reference concept for direct disposal envisages that the spent fuel assemblies should be packaged in sealed thick-walled containers and emplaced in deep geological formations. In order to demonstrate the conditioning technique, a pilot conditioning plant (PKA) was planned and constructed at Gorleben (Figure D–3). The plant is designed for a throughput of 35 tHM/a. Pursuant to the agreement between the Federal Government and the utilities of 14 June 2000 (signed on

11 June 2001) the licensing procedure is complete, but use of the facility is licensed only for the repair of defect containers for spent fuel assemblies from light-water reactors and for vitrified HAW from reprocessing abroad as well as for the handling of other radioactive materials. The lawsuits filed against the operating licence that went as far as to the Federal Administrative Court were all dismissed; the license is therefore valid.

Figure D–3: Segmenting cell inside the Gorleben pilot conditioning plant (Copyright: BLG)

Table D-1: a) Storage facilities for spent fuel assemblies (as at 31 December 2004)

| Site | Storage capacity | Storage capacity | Status | | Emplaced |
|---|---|---|---|---|---|
| | (Number of storage positions) | (tHM) | Applied for | Licensed | (tHM) as at 12/04 |
| **Fuel pools in reactor buildings** | | | | | |
| Nuclear power plants total | 19776 container positions[1)] | approx. 6119 tHM [1)] | | X | 3358 |
| **Onsite interim storage facilities** | | | | | |
| Biblis | 135 container positions | 1400 tHM | | X | |
| Brokdorf | 100 container positions | 1000 tHM | | X | |
| Brunsbüttel | 80 container positions | 450 tHM | | X | |
| Grafenrheinfeld | 88 container positions | 800 tHM | | X | |
| Grohnde | 100 container positions | 1000 tHM | | X | |
| Gundremmingen | 192 container positions | 1850 tHM | | X | |
| Isar | 152 container positions | 1500 tHM | | X | |
| Krümmel | 80 container positions | 775 tHM | | X | |
| Lingen/Emsland | 120 container positions | 1250 tHM | | X | 153 |
| Neckarwestheim | 151 container positions | 1600 tHM | | X | |
| Obrigheim[2)] | 980 positions | 286 tHM | | X | 44 |
| Philippsburg | 152 container positions | 1600 tHM | | X | |
| Unterweser | 80 container positions | 800 tHM | | X | |
| **Temporary storage facilities** | | | | | |
| Biblis | 28 container positions | 300 tHM | | X | 234 |
| Brunsbüttel | 18 container positions | 140 tHM | X | | |
| Krümmel | 12 container positions | 120 tHM | | X | 9 |
| Neckarwestheim | 24 container positions | 250 tHM | | X | 149 |
| Philippsburg | 24 container positions | 250 tHM | | X | 99 |
| **Centralised interim storage facilities** | | | | | |
| Gorleben | 420 container positions [3)] | 3800 tHM | | X | 38 |
| Ahaus | 420 container positions | 3960 tHM | | X | 58[4)] |
| **Local storage facilities outside the reactor sites** | | | | | |
| ZAB Greifswald | 4680 positions | 560 tHM | | X | 150 |
| ZLN Greifswald | 80 container positions | 585 tHM | | X | 407 |
| Jülich | 158 containers | 0.225 t nuclear fuel[5)] | | X | 0.075[5)] |

1) Part of the storage capacity has to be kept free for unloaded cores
2) The storage facility at Obrigheim is a wet storage facility outside of the reactor building that was commissioned in 1999.
3) Including the positions for HAW canisters
4) Total amount from power reactors; an additional approx. 6 tHM from the THTR
5) Excluding thorium

b) Conditioning plants

| Facility | Site | Purpose | Maximum throughput | Status |
|---|---|---|---|---|
| PKA | Gorleben | Conditioning of spent fuel assemblies for direct disposal; presently repair of defective containers | 35 tHM/a (conditioning) | Licensed and constructed but not yet in nuclear operation |

*Article 32 2.*

*(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;*

An overview of the spent fuel produced in German nuclear power plants up to the end of 2004 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.

18 power reactors (end of 2004) are currently operational in the Federal Republic of Germany, all of which are light water reactors whose fuel assemblies consist of low-enriched uranium dioxide or mixed uranium-plutonium oxide (MOX). A further 11 power reactors (end of 2004) have been shut down. 7 experimental and prototype power plants formerly operating in the Federal Republic of Germany have likewise been shut down. Two of them, HDR at Großwelzheim (completely dismantled since 1998) and VAK at Kahl, were boiling water reactors fuelled with low-enriched uranium dioxide pellets, whilst MOX was also used to a certain extent in the case of VAK. Two further reactors, AVR at Jülich and THTR at Hamm-Uentrop, were helium-cooled, graphite-moderated high-temperature reactors in which the fuel, consisting of medium- and high-enriched uranium/thorium oxide particles, was enclosed in graphite spheres. The MZFR at Karlsruhe was a heavy-water reactor with very low enriched (0.85 %) uranium dioxide fuel. The fast breeder reactor KNK II at Karlsruhe used fuel assemblies made of highly enriched uranium oxide and mixed uranium/plutonium oxide. The nuclear power plant at Niederaichbach (KKN) was operational as a prototype plant from 1972 to 1974 with a pressure tube reactor moderated with heavy water and cooled by $CO_2$, which used natural uranium as fuel. Complete dismantling (leaving behind a greenfield site) was finished in 1995.

## Spent Fuel Quantities

### Power Reactors

In November 2003, the Stade nuclear power plant was closed down. By the cut-off date of 31 December 2004, 11393 tonnes of heavy metal (tHM) in the form of spent fuel assemblies had been produced from 18 operating and 11 decommissioned power reactors (Table D-2). In 2004, almost 400 tHM were added to this. Part of the fuel assemblies in storage in the fuel pools are intended for re-use. Since, however, the Joint Convention does not make a distinction here, the fuel assemblies intended for re-use will be taken into account in this report in connection with the quantities of spent fuel assemblies (e. g. in Table D-2 and Table D-3).

3358 tHM of spent fuel assemblies are currently being stored in the cooling ponds of the power plants. There are 150 tHM of fuel assemblies from water-cooled, water-moderated energy reactors (WWER) at the wet storage facility ZAB in Lubmin near Greifswald. 491 tHM are currently housed in temporary storage facilities, 197 tHM in on-site interim storage facilities, and a further 96 tHM of LWR fuel assemblies are stored in storage containers at the central storage facilities at Ahaus and Gorleben. 407 tHM of WWER fuel assemblies from Rheinsberg and Greifswald are likewise stored in containers at the ZLN interim storage facility at Lubmin near Greifswald. A total of 6655 t of spent fuel assemblies from the nuclear power plants have already been shipped abroad either for reprocessing or for permanent storage there. The majority have been sent to the reprocessing plants at La Hague and Sellafield. Table D-3 gives an overview of the destinations of the fuel assemblies.

Table D-2: Quantities of spent fuel assemblies produced in power reactors in the Federal Republic of Germany until 31 December 2004

| Type | Abbr. | Power plant, site | Total quantity | |
|---|---|---|---|---|
| | | | **Number of Fuel Assemblies** | **tHM** |
| BWR | KKB | Brunsbüttel | 1908 | 332 |
| BWR | KKK | Krümmel | 2745 | 486 |
| PWR | KBR | Brokdorf | 812 | 439 |
| PWR | KKU | Unterweser | 1280 | 689 |
| PWR | KWG | Grohnde | 988 | 539 |
| PWR | KKE | Emsland | 876 | 471 |
| PWR | KWBA | Biblis A | 1307 | 699 |
| PWR | KWBB | Biblis B | 1367 | 731 |
| PWR | KWO | Obrigheim | 1138 | 332 |
| BWR | KKP1 | Philippsburg 1 | 2564 | 449 |
| PWR | KKP2 | Philippsburg 2 | 992 | 537 |
| PWR | GKN1 | Neckarwestheim 1 | 1449 | 520 |
| PWR | GKN2 | Neckarwestheim 2 | 756 | 407 |
| BWR | KRBB | Gundremmingen B | 3272 | 569 |
| BWR | KRBC | Gundremmingen C | 3165 | 551 |
| BWR | KKI1 | Isar 1 | 2956 | 514 |
| PWR | KKI2 | Isar 2 | 792 | 424 |
| PWR | KKG | Grafenrheinfeld | 1164 | 625 |
| **Subtotal:** | | | **29531** | **9314** |
| **Decommissioned plants:** | | | | |
| BWR | KWL | Lingen | 586 | 66 |
| BWR | KRB-A | Gundremmingen A | 1028 | 120 |
| BWR | KWW | Würgassen | 1989 | 346 |
| PWR | KMK | Mülheim-Kärlich | 209 | 96 |
| PWR | KKS | Stade | 1518 | 546 |
| PWR | KKR | Rheinsberg | 918 | 108 |
| PWR | KGR 1-4 | Greifswald 1-4 | 6464 | 755 |
| PWR | KGR 5 | Greifswald 5 | 349 | 42 |
| **Subtotal** | | | **13061** | **2079** |
| **Total:** | | | **42592** | **11393** |

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

Table D-3: Overview of total quantities of spent fuel assemblies from German power reactors up to 31 December 2004:

| | | |
|---|---|---|
| Spent LWR fuel assemblies in wet stores at nuclear power plants (incl. Obrigheim on-site | 3402 | tHM |
| Spent WWER fuel assemblies in the ZAB wet storage facility | 150 | tHM |
| Spent WWER fuel assemblies stored in containers at Greifswald NPP | 30 | tHM |
| Dry storage of spent WWER fuel assemblies in containers at ZLN | 407 | tHM |
| Dry storage in containers at nuclear power plant sites | 653 | tHM |
| Dry storage in containers at the Ahaus and Gorleben interim storage facilities | 96 | tHM |
| Shipped to La Hague (France) for reprocessing | 5362 | tHM |
| Shipped to Sellafield (United Kingdom) for reprocessing | 853 | tHM |
| Reprocessed at the WAK reprocessing plant in Karlsruhe | 90 | tHM |
| Reprocessed at the Mol reprocessing plant (Belgium) | 15 | tHM |
| Returned to the former USSR (WWER fuel assemblies) | 290 | tHM |
| Shipped permanently to Sweden (CLAB) | 17 | tHM |
| Re-use of WWER fuel assemblies at Paks (Hungary) | 28 | tHM |
| **Total** | **11393** | **tHM** |

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

**Research Reactors**
At the start of 2004, there were 13 research reactors in operation in Germany, comprised of:

- 4 materials test reactors (MTRs) (Berlin, Geesthacht, Jülich and Munich)
- 1 TRIGA reactor at Mainz
- 8 training / educational reactors, including 6 Siemens educational reactors (SUR).

Furthermore, 7 reactors with thermal outputs in excess of 1 MW have been shut down and are in varying stages of decommissioning. Several other lower-output reactors have been decommissioned or have already been dismantled. A list of decommissioned research reactors can be found in the Annex to this report, cf. Table L-12 and Table L-13.

Around 6 t of spent fuel assemblies were stored at the sites of these reactors by mid-2004. Because the fuel in research reactors is bound in an aluminium alloy, the indicated masses do not refer to the content of heavy metal, as it is the case for power reactors, but to the total weight of the fuel assemblies.

**Prototype reactors**
Seven experimental and prototype reactors were once operated in Germany, all of which have since been decommissioned. These are:

- AVR, Jülich
- THTR-300, Hamm
- MZFR, Karlsruhe
- KNK-2, Karlsruhe
- VAK, Kahl
- KKN, Niederaichbach
- HDR, Großwelzheim

For comparative data on these reactors, please refer to Table L-11 in the Annex. Table D-4 lists the destinations and respective heavy metal quantities for storage or management of the 186 t HM of spent fuel assemblies thereby incurred.

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

| **Reactor** | **Quantities stored or disposed of (in t HM) at** | | | | | | | | **Total** |
|---|---|---|---|---|---|---|---|---|---|
| | **WAK** | **BNFL** | **SKB** | **CEA** | **EURO-CHEMIC** | **FZ Jülich** | **TBL-A Ahaus** | **Others** | |
| VAK | 7.9 | 0.1 | 6.5 | | 7.4 | | | 0.1 | 22.0 |
| MZFR | 89.6 | 10.6 | 0.4 | | | | | | 100.6 |
| KKN | | | | 46.3 | | | | | 46.3 |
| KNK-2 | | | | 1.9 | | | | 0.2 | 2.1 |
| AVR | | | | | | 1.1 | | | 1.1 |
| THTR | | | | | | | 6.9 | | 6.9 |
| HDR | 6.9 | | | | | | | | 6.9 |
| **Total** | **104.4** | **10.7** | **6.9** | **48.2** | **7.4** | **1.1** | **6.9** | **0.3** | **185.9** |

Most of the spent fuel assemblies listed in the above table were reprocessed at WAK Karlsruhe, at BNFL or at EUROCHEMIC in Belgium. A smaller part of the fuel assemblies was shipped to SKB in Sweden or to CEA in France and will remain there. The THTR fuel assembly spheres have already been declared as radioactive waste (cf. the remarks on Article 32 2. (iv)) and are currently being stored at the Ahaus interim storage facility. The 6.9 t of heavy metal are contained in 617629 spheres which are stored in 305 containers. The AVR fuel assembly spheres are stored at the Jülich research centre, where 240962 fuel assembly spheres with 1.1 t of heavy metal (including thorium) have been emplaced in 127 containers. The proper waste management of the spent fuel assemblies from prototype reactors has thereby been ensured.

**<u>Inventory of Spent Fuel Assemblies</u>**

**Activity**

The activity of the spent fuel assemblies (reference date: 31 December 2001) stored on-site at the reactors and in the container storage facilities can be estimated based on the following assumptions:

In an initial approximation, only uranium dioxide fuel is considered. The fuel assemblies are divided into different categories on the basis of age: for those fuel assemblies unloaded prior to 1998, the assumed mean burn-up is 40 GWd/tHM, whilst for those unloaded between 1999 and 2004, the mean burn-up is assumed as 45 GWd/tHM.

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

- Inventory of spent fuel stored in NPP cooling ponds $1.4 \cdot 10^{20}$ Bq
  (corresponding to 3402 t HM)
- Spent fuel assemblies in containers, interim and temporary storage facilities $2.6 \cdot 10^{19}$ Bq
  (corresponding to 1336 t HM)

Thus, the total activity of all spent fuel assemblies currently in storage as per the reference date is approximately $1.6 \cdot 10^{20}$ Bq.

The activity of Sr-90/Y-90 can be estimated at $2.8 \cdot 10^{19}$ Bq, whilst the activity of Cs-137/Ba-137m can be estimated at $3.9 \cdot 10^{19}$ Bq.

*Article 32 2.*

*(iii) a list of the radioactive waste management facilities subject to this Convention, their location, main purpose and essential features;*

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

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

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

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

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

Until shipped into a repository for disposal, radioactive waste from the operation and decommissioning of nuclear power plants must be stored intermediately in facilities to be erected and operated by the waste producer in accordance with the polluter pays principle. At present, in addition to on-site facilities, intermediate storage facilities are also available at the Gorleben waste storage facility, the interim storage facility of the Bavarian utilities in Mitterteich, the external storage hall in Unterweser, the North interim storage facility (Zwischenlager Nord, ZLN) near Greifswald and the interim storage of the Decontamination Plants Division (*Hauptabteilung Dekontaminationsbetriebe = HDB)* in Karlsruhe. The licences for these interim storage facilities contain restrictions regarding delivery. For example, only waste originating from Bavarian nuclear facilities may be brought to Mitterteich, only waste from the nuclear facilities in Greifswald and Rheinsberg currently in the process of decommissioning may be brought to the ZLN, and only waste originating from operation and decommissioning of facilities of the FZK and decommissioning wastes of the nuclear power plant at Niederaichbach may be brought to the HDB. Radioactive waste from the reprocessing of German spent fuel assemblies abroad may be stored in the central interim storage facility in Gorleben.

Radioactive waste from large research institutions is conditioned and stored intermediately at its place of origin. Waste from research, industry and medicine may be delivered to 11 regional State 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 most notably AEA Technology QSA GmbH, are additionally available for waste from research, medicine and industry. This company collects radioactive residues from the whole of Germany and intermediately stores radioactive waste at its storage facility in Leese (Lower Saxony). Waste from the nuclear industry is either stored on site or in central interim storage facilities in a conditioned form suitable for disposal.

All intermediately stored radioactive waste which cannot be released once activity has subsided is intended for subsequent disposal in a repository. There are plans to dispose of the radioactive waste in deep geological formations. Development work in the repository field began with the establishment of the Asse research mine in a salt dome near Wolfenbüttel (Lower Saxony), where the disposal of low-level and medium-level radioactive waste was trialled up until the end of 1978. In the former GDR, the Morsleben repository for radioactive waste (ERAM) in Saxony-Anhalt was available for the disposal of low-level and medium-level radioactive waste. Following Germany's reunification, ERAM was taken over and accepted waste from nuclear power plants and from research, medicine and industry in Germany up until September 1998.

In 1982, an application was filed to dispose of non-heat-generating waste at the Konrad repository, a former iron ore mine in Lower Saxony. The licensing procedure for the Konrad repository has been concluded and was issued solely to meet national requirements, for a maximum emplaceable waste package volume of 303000 m³. A licence was granted on 22 May 2002, but has not yet entered into force because an appeal has been launched against the decision.

At the Gorleben site (Lower Saxony), underground exploration work of the salt dome located there started in 1986, in order to ascertain whether the salt dome might be suitable in particular for use as a repository for high-level radioactive waste. Within the context of exploration, two shafts of approximately 800 m depth were sunk and connected to one another. Exploration of the Gorleben salt dome was interrupted on 1 October 2000 for a minimum of three years but no more than ten years. During this moratorium period, the mine will remain open. The interruption will be used to clarify safety-related and conceptual issues relating to final disposal.

*Article 32 2.*

*(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;*

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

- the operation of nuclear power plants,
- uranium enrichment and the production of fuel assemblies (nuclear industry),
- the decommissioning and dismantling of nuclear power plants, research, demonstration and educational reactors, and other nuclear installations,
- basic and applied research,
- the use of radioisotopes in other research institutions, universities, trade and industry companies, hospitals and medical practices,

- other waste producers, such as the military sector,
- the future conditioning of spent fuel assemblies to prepare them for direct disposal.

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

- According to contractual agreements with the reprocessing companies COGEMA – Compagnie Générale des Matières Nucléaires (France) and BNFL – British Nuclear Fuels plc (United Kingdom), Germany must accept the return of an equivalent amount of radioactive waste obtained from the reprocessing of spent fuel assemblies from light-water reactors. Whilst return of the vitrified fission product concentrate from COGEMA/France commenced in May 1996 and will continue at regular intervals, the return delivery of radioactive waste from BNFL is currently still at the planning stage.
- Further contracts were concluded with the United Kingdom (UKAEA – United Kingdom Atomic Energy Agency) to reprocess a limited number of spent fuel assemblies from research reactors. The radioactive waste generated from reprocessing will likewise 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 2001, and an estimate of the current level of capacity utilization at the storage facilities for radioactive waste. An overview of the radioactive waste disposed of in the ERAM repository at Morsleben and the waste emplaced in the Asse research mine is also provided.

**a) Inventory of Radioactive Waste**

Those obliged to surrender/hand over radioactive waste, the inventory of radioactive waste, and the number and types of waste containers, both for waste with negligible heat generation and for heat-generating radioactive waste, can be found in the tables below. Those obliged to surrender/hand over radioactive waste and their assignment to waste producer groups are listed in Table D-5, which is updated annually.

Table D-5 : Those obliged to surrender/hand over radioactive waste and their assignment to waste producer groups

| Obliged to surrender/hand over radioactive waste | Group |
|---|---|
| Europäisches Institut für Transurane - ITU - | Research institution |
| Forschungs- und Messreaktor Braunschweig - FMRB | Research institution |
| Research Reactor Munich - FRM | Research institution |
| Research Reactor Munich – FRM II | Research institution |
| Forschungszentrum Geesthacht GmbH | Research institution |
| Forschungszentrum Jülich GmbH - FZJ - | Research institution |
| Forschungszentrum Karlsruhe GmbH - FZK - | Research institution |
| Hahn-Meitner-Institut Berlin GmbH | Research institution |
| Institut für Radiochemie TU München | Research institution |
| VKTA Rossendorf | Research institution |
| Advanced Nuclear Fuels GmbH | Nuclear industry |
| Nukem GmbH | Nuclear industry |
| Siemens AG Power Generation Rückbauprojekte | Nuclear industry |
| Framatome ANP GmbH | Nuclear industry |
| Urenco GmbH Gronau | Nuclear industry |
| Urenco GmbH Jülich | Nuclear industry |
| Biblis A und B nuclear power plant | Nuclear power plant |
| Brokdorf nuclear power plant | Nuclear power plant |
| Brunsbüttel nuclear power plant | Nuclear power plant |
| Emsland nuclear power plant | Nuclear power plant |
| Grafenrheinfeld nuclear power plant | Nuclear power plant |

| Obliged to surrender/hand over radioactive waste | Group |
|---|---|
| Grohnde nuclear power plant | Nuclear power plant |
| Gundremmingen nuclear power plant, units B and C | Nuclear power plant |
| Isar 1 nuclear power plant | Nuclear power plant |
| Isar 2 nuclear power plant | Nuclear power plant |
| Krümmel nuclear power plant | Nuclear power plant |
| Neckarwestheim nuclear power plant, units 1 and 2 | Nuclear power plant |
| Philippsburg nuclear power plant, units 1 and 2 | Nuclear power plant |
| Unterweser nuclear power plant | Nuclear power plant |
| Greifswald nuclear power plant | Decommissioned nuclear power plant |
| Gundremmingen nuclear power plant, unit A | Decommissioned nuclear power plant |
| Hamm-Uentrop - THTR – nuclear power plant | Decommissioned nuclear power plant |
| Jülich - AVR – nuclear power plant | Decommissioned nuclear power plant |
| Lingen nuclear power plant | Decommissioned nuclear power plant |
| Mülheim-Kärlich nuclear power plant | Decommissioned nuclear power plant |
| Obrigheim nuclear power plant | Decommissioned nuclear power plant |
| Rheinsberg nuclear power plant | Decommissioned nuclear power plant |
| Stade nuclear power plant | Decommissioned nuclear power plant |
| Würgassen nuclear power plant | Decommissioned nuclear power plant |
| Kernkraftwerk-Betriebsgesellschaft KNK of FZK | Decommissioned nuclear power plant |
| Kernkraftwerk-Betriebsgesellschaft MZFR of FZK | Decommissioned nuclear power plant |
| Versuchsatomkraftwerk Kahl - VAK - | Decommissioned nuclear power plant |
| Abfalllager Gorleben - ALG - | Others |
| AEA Technology QSA GmbH | Others |
| Military sector | Others |
| Karlsruhe reprocessing plant – WAK - | Decommissioned reprocessing plant |
| Baden-Württemberg collecting facility | State collecting facility |
| Bavaria collecting facility | State collecting facility |
| Berlin collecting facility | State collecting facility |
| Hesse collecting facility | State collecting facility |
| Mecklenburg-Western Pomerania collecting facility | State collecting facility |
| Lower Saxony collecting facility | State collecting facility |
| North Rhine-Westphalia collecting facility | State collecting facility |
| Rhineland-Palatinate collecting facility | State collecting facility |
| Saarland collecting facility | State collecting facility |
| Saxony collecting facility | State collecting facility |
| Schleswig-Holstein collecting facility | State collecting facility |
| Brandenburg provisional storage facility | State collecting facility (until 31st December 2001) |

The inventory of radioactive waste is determined both for radioactive waste with negligible heat generation, and for heat-generating radioactive waste. Table D-6 contains summarised data for the year 2001 for primary waste (untreated waste), interim products (treated waste), and waste packages (conditioned waste). This list does not include the inventory of spent fuel assemblies (cf. remarks on Article 32 2. (ii)). The data on conditioned waste refers to the waste package volume.

Table D-6: Overview of the volumes of radioactive waste in interim storage as at 31 December 2001 [m³]

| Type of residue | With negligible heat generation | Heat-generating |
|---|---|---|
| Untreated waste (raw waste with residues yet to be recycled) | 42905 | 448 |
| Interim products | 4675 | |
| Conditioned waste | 71261 | 1559 |

In total, 42905 m³ of untreated waste was held in storage by all waste producers; this also includes utilisable residues which may be reused or released following appropriate action. The inventory of interim products with negligible heat generation totalled 4675 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 71261 m³ as per 31 December 2001. These inventories were likewise held in storage both at the waste producers and at interim storage facilities.

On 31 December 2001, conditioned radioactive waste was stored in the form of 60220 waste packages. This inventory is subdivided into

- 58882 waste packages with negligible heat generation and
- 1338 waste packages with heat-generating waste.

Most of the processed waste with negligible heat generation is stored in drums, cylindrical concrete and cast-iron containers, and sheet-steel and concrete boxed-shape containers.

Drums were used with varying capacities of 200 litres, 280 litres, 400 litres and 570 litres.

Detailed data on the inventory of conditioned waste as per 31 December 2001 regarding the waste containers used are summarised in Table D-7 for waste with negligible heat generation and in Table D-8 for heat-generating waste.

Table D-7: Breakdown of the inventory of conditioned radioactive waste with negligible heat generation as at 31 December 2001 according to container type

| Packaging of conditioned radioactive waste | Quantity |
|---|---|
| 200 litre drum | 40833 |
| 280 litre drum | 1938 |
| 400 litre drum | 1679 |
| 570 litre drum | 295 |
| Concrete container | 9316 |
| Cast-iron container | 4220 |
| Box-shaped container | 5823 |
| **Total** | **58882** |

Table D-8: Breakdown of the inventory of conditioned heat-generating waste as at 31 December 2001 according to container type

| Packaging of conditioned radioactive waste | Quantity |
|---|---|
| 200 litre drum | 607 |
| Type II cast-iron container | 6 |
| CASTOR® THTR/AVR[1)] | 305 |
| CASTOR® HAW 20/28 CG[2)]<br>TS 28 V | 50<br>1 |
| **Total** | **913** |

1) Article 32 2. (ii) (prototype reactors) also reports on the spent fuel assemblies contained in containers of the type CASTOR® THTR/AVR.
2) as at 31 December 2004

Table D-9 shows the inventory of waste with negligible heat generation related to the individual waste producer groups.

Table D-9: Overview of the inventory of untreated primary waste, interim products and conditioned waste with negligible heat generation as per 31 December 2001 [m³]

| Waste producer group | Untreated primary waste | Interim products | Conditioned waste |
|---|---|---|---|
| Research institutions | 7198 | 586 | 34465 |
| Nuclear industry | 17760 | 144 | 3592 |
| Nuclear power plants | 7288 | 686 | 13242 |
| Decommissioned nuclear power plants | 6899 | 2182 | 4600 |
| State collecting facilities | 1010 | 1060 | 2307 |
| Others | 2003 | 17 | 604 |
| Reprocessing | 747 | | 12451 |
| **Total** | **42905** | **4675** | **71261** |

The mean annual production of conditioned waste with negligible heat generation totals approximately 4604 m³.

In addition to the inventory of radioactive waste with negligible heat generation, some 448 m³ of heat-generating primary waste and 1559 m³ of heat-generating conditioned waste was held in storage in the Federal Republic of Germany as per 31 December 2001. The bulk of this originated from decommissioned nuclear power plants, particularly the Hamm-Uentrop high-temperature reactor (THTR). It is envisaged that the spherical fuel assemblies discharged from the THTR will be disposed of directly. 15 containers with 420 canisters containing vitrified fission product concentrate from the reprocessing of spent fuel assemblies at COGEMA are included under conditioned reprocessing waste. Heat-generating primary waste refers to fission product concentrate from the Karlsruhe reprocessing plant (WAK) and core scrap originating from the Würgassen nuclear power plant. Table D-10 contains a breakdown of heat-generating waste according to origin.

Table D-10: Overview of the inventory of untreated primary waste and conditioned heat-generating waste as at 31 December 2001 [m³]

| Waste producer group | Untreated primary waste | Conditioned waste |
|---|---|---|
| Research institutions | - | 83 |
| Nuclear industry | - | - |
| Nuclear power plants | - | 6 |
| Decommissioned nuclear power plants | 388 | 1320 |
| State collecting facilities | | 19 |
| Others | - | - |
| Reprocessing | 60 | 131 |
| **Total** | **448** | **1559** |

Conditioned radioactive waste, both with negligible heat generation and heat-generating, is stored at the waste producers´ sites and at internal and central interim storage facilities. Table D-11 summarises the inventory of conditioned radioactive waste with negligible heat generation, classified according to the various interim storage facilities.

Table D-11: Interim storage of conditioned waste with negligible heat generation as at 31 December 2001 [m³]

| Interim storage facility | Waste volume |
|---|---|
| Research centres including clients | 50454 |
| Nuclear industry | 2074 |
| Energiewerke Nord, Zwischenlager Nord | 1850 |
| Light water reactors | 5129 |
| Decommissioned reactors | 200 |
| State collecting facilities | 1141 |
| Others | 1005 |
| Interim storage facility at the Unterweser nuclear power plant | 504 |
| Interim storage facility at the Mitterteich utility | 3385 |
| GNS Gorleben facility (ALG) | 4474 |
| GNS and other interim storage facilities | 1045 |
| **Total** | **71263** |

## b) Disposed of Radioactive Waste

### ERAM

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

This waste originated from

- the operation of nuclear power plants,
- the decommissioning of nuclear facilities,

- the nuclear industry,
- research institutions,
- State collecting facilities or directly from small waste producers, and
- other users of radioactive materials.

In total, some 36753 m³ of solid waste and 6617 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-litre drums and cylindrical concrete containers. The sealed radiation sources are not subjected to further treatment nor are they packaged. In addition to the disposed of radioactive waste, sealed cobalt radiation sources, some caesium radiation sources, and small quantities of solid medium-level waste (europium waste) in seven special containers (steel cylinders) with a volume of 4 litres each and one 280 litre drum containing radium-226 waste are intermediately stored in deep boreholes at the ERAM facility. Within the scope of the licensing procedure for the decommissioning of the ERAM repository, an application was submitted to dispose of this intermediately stored waste.

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

Radioactive waste from State 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 litre 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-12 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 30 June 2005.

Table D-12: Radionuclide inventory of relevant radionuclides in the ERAM repository as at June 2005

| Radionuclide | Activity in Bq | Radionuclide | Activity in Bq |
|---|---|---|---|
| H-3 | $3.2 \cdot 10^{12}$ | Th-229 | $4.5 \cdot 10^{5}$ |
| C-14 | $3.4 \cdot 10^{12}$ | Th-230 | $1.7 \cdot 10^{6}$ |
| Cl-36 | $3.8 \cdot 10^{9}$ | Th-232 | $5.8 \cdot 10^{6}$ |
| Ca-41 | $7.3 \cdot 10^{7}$ | Pa-231 | $1.6 \cdot 10^{6}$ |
| Co-60 | $2.5 \cdot 10^{14}$ | U-233 | $5.0 \cdot 10^{6}$ |
| Ni-59 | $1.8 \cdot 10^{11}$ | U-234 | $1.1 \cdot 10^{9}$ |
| Ni-63 | $1.8 \cdot 10^{13}$ | U-235 | $8.2 \cdot 10^{7}$ |
| Se-79 | $1.9 \cdot 10^{8}$ | U-236 | $4.9 \cdot 10^{7}$ |
| Rb-87 | $2.8 \cdot 10^{7}$ | U-238 | $4.3 \cdot 10^{8}$ |
| Sr-90 | $5.9 \cdot 10^{12}$ | Np-237 | $8.5 \cdot 10^{7}$ |
| Zr-93 | $9.3 \cdot 10^{9}$ | Pu-239 | $6.8 \cdot 10^{10}$ |
| Nb-94 | $2.6 \cdot 10^{10}$ | Pu-240 | $6.6 \cdot 10^{10}$ |
| Mo-93 | $2.6 \cdot 10^{8}$ | Pu-242 | $1.2 \cdot 10^{8}$ |
| Tc-99 | $1.0 \cdot 10^{11}$ | Pu-244 | $2.1 \cdot 10^{4}$ |
| Pd-107 | $6.7 \cdot 10^{7}$ | Am-241 | $2.2 \cdot 10^{11}$ |
| Sn-126 | $2.4 \cdot 10^{8}$ | Am-243 | $9.5 \cdot 10^{7}$ |
| I-129 | $2.1 \cdot 10^{8}$ | Cm-244 | $6.6 \cdot 10^{9}$ |
| Cs-135 | $3.7 \cdot 10^{8}$ | Cm-245 | $2.3 \cdot 10^{6}$ |
| Cs-137 | $1.4 \cdot 10^{14}$ | Cm-246 | $2.7 \cdot 10^{6}$ |
| Sm-151 | $2.7 \cdot 10^{11}$ | Cm-247 | $2.6 \cdot 10^{4}$ |
| Pu-241 | $1.4 \cdot 10^{12}$ | Cm-248 | $2.2 \cdot 10^{7}$ |
| Ra-226 | $3.9 \cdot 10^{11}$ | | |

The bulk of the emplaced waste volume originates from operational and decommissioned nuclear power plants. As the limit for the activity of alpha-emitters was very low at ERAM ($4 \cdot 10^{8}$ Bq/m³), the portion of the waste originating from the nuclear industry, research centres and reprocessing is low. Table D-13 shows the volume of waste emplaced in the ERAM repository, classified according to individual waste producer groups.

Table D-13: Volume emplaced in the Morsleben repository (ERAM) according to individual waste producer groups

| Waste producer group | Volume in m³ |
|---|---|
| Nuclear power plants | 23816 |
| Decommissioned nuclear power plants | 6528 |
| Research institutions | 2592 |
| Nuclear industry | 159 |
| State collecting facilities | 3090 |
| Others | 523 |
| Reprocessing | 45 |
| **Total** | **36753** |

**Asse Research Mine**

In 1967, the trial emplacement of low-level waste began in the former Asse salt mine; in 1972, medium-level waste followed. In 1978, the emplacement licences expired, and trial operation was continued without any further emplacements. Until then, a total of 47000 m³ had been emplaced in 200 and 400-l drums or in cylindrical concrete containers:

- 124494 waste packages holding low-level waste with a total activity of approx. $1.9 \cdot 10^{15}$ Bq (as at 31 December 2001). These represent 60 % of the total activity in the Asse research mine and are distributed over 11 rooms at the 750-m level and one room at the 725-m level.
- 1293 drums holding medium-level waste with a total activity of around $1.2 \cdot 10^{15}$ Bq (as at 31 December 2001). These represent 40 % of the total activity and are stored in a room at the 511-m level.

The low-level waste consists of solidified concentrates, ashes from combustion processes, laboratory waste, scrap, medical preparations, contaminated equipment, clothing and air filters from nuclear facilities.

The medium-level waste stems mainly from the Karlsruhe reprocessing plant (WAK).

No high-level waste nor any spent fuel assemblies were emplaced in the Asse research mine. Table D-14 summarises the percentages of the waste packages emplaced with regard to number and activity by delivering party.

Table D-14: Percentages of the waste packages emplaced with regard to number and activity by delivering party (waste origin)

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

At the time of emplacement, the total activity declared by the delivering parties was $7.8 \cdot 10^{15}$ Bq. Table D-15 provides an overview of the activity of the relevant radionuclides of the waste emplaced in the Asse research mine.

Table D-15: Inventory of relevant radionuclides in the Asse research mine as at 31 December 2001

| Radionuclide | Total activity [Bq] |
|---|---|
| H-3 | $1.3 \cdot 10^{12}$ |
| C-14 | $3.9 \cdot 10^{12}$ |
| J-129 | $3.2 \cdot 10^{8}$ |
| Ra-226 | $2.0 \cdot 10^{11}$ |
| Th-232 | $3.5 \cdot 10^{11}$ |
| U-235 | $5.2 \cdot 10^{10}$ |
| U-236 | $1.3 \cdot 10^{10}$ |
| U-238 | $1.3 \cdot 10^{12}$ |
| Pu-239 | $1.9 \cdot 10^{13}$ |
| Pu-241 | $1.1 \cdot 10^{15}$ |

**c) Inventory of Material from Past Practices**

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

*Article 32 2.*

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

**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 Section 7, para. 3 of the Atomic Energy Act (AtG) or if such a licence has been granted (cf. the remarks on Article 26). Within the meaning of this Convention, such facilities are classified as “in the process of being decommissioned”. Table D-16 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-11 to Table L-15.

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 reuse.

Table D-16: Overview of facilities in Germany currently in the process of decommissioning or released from regulatory control

| Type of facility | In the process of decommissioning | Fully removed or released from regulatory control |
|---|---|---|
| Reactors with electrical power generation (nuclear power plants, prototype reactors) | 17 reactor units | 2 reactor units |
| Research reactors ≥ 1 MW thermal power (incl. nuclear ship Otto Hahn) | 8 reactors | - |
| Research reactors < 1 MW thermal power | 6 reactors | 18 reactors |
| Fuel cycle facilities (primarily commercial production and reprocessing of fuel assemblies) | 2 facilities | 4 facilities |
| Research and prototype fuel cycle facilities | - | 3 facilities |

## Power Reactors

The 17 reactor units with electricity generation which are currently in the process of decommissioning or for which a decommissioning licence had been applied for as per 31 December 2004, include 7 prototype and demonstration facilities, as well as the nuclear power plants at Greifswald (KGR), Rheinsberg (KKR), Würgassen, Mülheim-Kärlich (KMK), Stade (KKS) and Obrigheim (KWO). In addition, the nuclear power plant Niederaichbach (KKN) and the Heißdampfreaktor Kahl (HDR) have been fully dismantled and the sites have been cleared for non-nuclear use.

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

## Research Reactors

Eight research reactors with thermal powers of 1 MW or more were in various stages of decommissioning as per 31 December 2004. Of the 24 research reactors with thermal powers of less than 1 MW which are no longer operational, the majority have already been fully removed, including a number of zero output reactors for educational purposes.

## Fuel Cycle Facilities

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

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

## Status of Current Decommissioning Projects

### Würgassen Nuclear Power Plant (KWW)

The Würgassen nuclear power plant (KWW) was one of the first commercially operated nuclear power plants in Germany. It had a boiling water reactor with an electrical output of 670 MWe and started operation in 1971. Cracks in the core shroud were discovered during maintenance work in 1994, the likes of which had already been observed in a similar form in plants in the USA, Sweden, South Korea and Switzerland. Safety analyses showed that these cracks had at no time affected the safe operation of the plant and that continued operation would have been possible for a limited period of time. However, a decision was made to decommission the plant in late May 1995, based on financial considerations.

Direct dismantling was chosen as the decommissioning variant. Decommissioning was separated into six phases, each of which was covered by an individual licence. This step-by-step approach was designed to shorten the length of time required until granting of the first licence and to optimise the subsequent procedure by preparing for subsequent stages at the same time as carrying out those stages which had already been licensed.

At present, the first five phases out of a total of six have been licensed.

1. The first licence to decommission KWW was issued in April 1997. It comprises the decommissioning and dismantling of various parts of the plant, primarily in the turbine hall and in the building which houses the independent residual heat removal system and the emergency scram system.
2. The dismantling of contaminated parts, mainly pipes and valves in various systems in the reactor building, began in January 1998.
3. The licence to dismantle the pressure suppression system and various mobile reactor components was granted in July 1999.
4. The licence for the phases four and five was issued in September 2002. The reactor pressure vessel, the biological shield and the pressure suppression system are dismantled in phase four. In addition, the empty building which had housed the independent residual heat removal system has been converted into an interim storage facility for radioactive waste which commenced operation in 2005.
5. During phase five, the remaining technical equipment will be removed from those buildings which are no longer required. It will then be checked whether the remaining activity in those buildings complies with clearance levels.
6. The demolition of the buildings and the recultivation of the site are scheduled for phase six. Some buildings may, however, be kept and re-used for industrial purposes. The buildings which contain interim storage facilities for radioactive waste will be maintained until the waste can be transferred into a repository.

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

In terms of the project schedule, the dismantling and decontamination techniques used, and the materials and waste management, the decommissioning of KWW can be regarded as typical of larger commercial nuclear power plants in Germany.

**Greifswald Nuclear Power Plant (KGR)**

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 1990, the first four units (type WWER-440/W-230) had been in commercial operation since the Seventies (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 “Interim Storage for Spent Fuel” (ZAB) and the “Central Active Workshop” (ZAW).

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

Dismantling of the entire complex is expected to take around 15 years, at which time it will be released from the purview of the Atomic Energy Act. The decision to opt for direct dismantling was based on a variety of factors, including technical and legal viability, the preservation of as many jobs as possible and hence also of available expert knowledge of the plant, and the avoidance of substantial rebuilding work to facilitate safe enclosure.

It would have been impossible to immediately remove all the spent fuel assemblies stored in the cooling ponds in the reactor buildings and in the interim storage facility for spent fuel prior to granting the decommissioning license. As a result, decommissioning began at a time when nuclear fuel and operational wastes were still present in the plant, which is an atypical situation for the decommissioning of power reactors.

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

The project itself is carried out over a number of licensing steps. The dismantling of components of unit 5 and in the monitored areas has been followed by the pilot dismantling of unit 5, the results of which is now used in dismantling units 1 and 2. The dismantling of parts and components in unit 5 began in November 1995. Due to the low level of contamination in this unit and the swift progress made with the work, installation of the equipment for the remote-controlled dismantling of the reactors could begin as early as 1997 as part of model dismantling. The model dismantling was carried out with components of the unfinished units 7 and 8 and has meanwhile been completed. The installations for remote dismantling have now been transferred to the steam generator annulus of unit 1. Here, the remote controlled segmenting of activated reactor internals of units 1 and 2 is carried out. The reactor pressure vessel of unit 5 was only slightly activated due to the short operating time and could therefore be dismantled as a whole and be transferred into the ZLN. So far, about 60 % of the components of units 1 to 6 have been dismantled and removed from the plant.

A vital part of the overall concept for decommissioning has been the construction of the Interim Storage Facility North (*Zwischenlager Nord*, ZLN) at the KGR site. The ZLN accepts spent fuel assemblies from the cooling ponds in the reactor buildings and from the ZAB, as well as from the nuclear power plant at Rheinsberg (KKR). In addition, the ZLN serves as an interim storage facility for radioactive wastes from KGR and KKR until they can be emplaced in a repository.

The ZLN also boasts conditioning and segmenting equipment and thus plays a key role in handling the large waste streams generated from the dismantling of KGR, because the segmenting of large components ex situ can be decoupled from the decommissioning progress in the plant itself. For example, unsegmented large components like the reactor pressure vessels are being stored there for decay (the reactor pressure vessel of unit 5 has been transferred in December 2003). The decoupling of dismantling and decay during storage has been proven to be a vital of the overall decommissioning concept of KGR. The material quantities generated at KGR are very different from those found in nuclear power plants of western design, because much larger amounts of material, particularly concrete, were used in the construction in relation to output. The total mass amounts to some 1.8 million tonnes, around 570000 t of which (metallic components, building rubble and building structures) will either have to be disposed of as radioactive waste, or else released following decontamination and clearance measurements. At present, it is not yet possible to quantify which percentages of this mass will be disposed of and released.

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

KGR is a unique, very large decommissioning project. However, the project procedure used cannot be directly transferred to other German nuclear power plants scheduled for decommissioning in the future. Nevertheless, valuable experience for the safe and efficient decommissioning of nuclear power plants with WWER reactors in the countries of Central and Eastern Europe and the CIS can be drawn from this project.

**Stade Nuclear Power Plant (KKS)**

The Stade nuclear power plant (KKS) was a power plant with a pressurised water reactor with an electrical output of 630 MWe. Additional power was provided in the form of long-distance heating to a salt works. The plant started operation in 1972 and was finally shut down on 14 November 2003. Early dismantling was chosen as decommissioning strategy. A licence covering decommissioning, residual operations, dismantling phase 1 and the interim storage facility for radioactive waste will be issued shortly. The entire dismantling phase is scheduled to last from 2005 until around 2014. Dismantling is structured into several phases, similar to those described for the Würgassen nuclear power plant. After termination of nuclear surveillance, conventional dismantling of the buildings to a green-field state could be reached by the end of 2015.

The fuel assemblies were fully removed prior to the start of decommissioning and have been shipped for reprocessing. The radioactive waste will be stored at a planned storage facility at the KKS site until it can be transferred into a repository.

As the shut-down of KKS was planned in advance, decommissioning and dismantling could be prepared over a long time. As an example, the application for the decommissioning licence (phase 1) was already submitted to the competent authority in July 2001. Prior to and after that date, planning was carried out, and the documents necessary for substantiating the licence application were prepared. Because of this long preparation phase, KKS could take advantage of the experience gained from other ongoing or completed decommissioning projects.

**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 separated uranium and plutonium were used in the production of new fuel assemblies, whilst the separated high-level waste was intermediately stored at WAK until its vitrification. In total, some 208 t of spent fuel from research and power reactors was reprocessed at WAK using the PUREX process (*P*lutonium *U*ranium *R*ecovery *Ex*traction). 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 the WAW plant planned at Wackersdorf, whose construction had already begun) and developing a process management system. Following the decision in 1989 to halt the reprocessing of nuclear fuels in Germany and instead ship the waste to reprocessing plants in other European countries, the continued operation of WAK and the construction of WAW became superfluous.

WAK finally ceased operation at the end of 1990 and the first decommissioning license was granted in 1993. A key pre-requisite for the decommissioning of WAK is the separation of decontamination and dismantling operations in the former process buildings from the handling and conditioning of the high-level liquid waste. For this purpose, the Karlsruhe Vitrification Plant (*Verglasungseinrichtung Karlsruhe*, VEK) has been constructed directly at the WAK site, where the highly active waste is mixed with melted special glass and poured into stainless steel canisters. The solidified glass safely contains the highly active waste. The welded containers are put into CASTOR® casks and held in interim storage until they can be emplaced in a repository for heat generating waste. The operating licence is expected for the course of the year 2006. It is envisaged that VEK will be shut down and dismantled once it has served its purpose for WAK. It has not yet been decided where the containers will be stored, suitable storage facilities are available in Germany.

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

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

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

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

The decommissioning and dismantling of WAK differs from the decommissioning of other fuel cycle installations in terms of overall scope, the effort involved, the need for remote controlled segmenting techniques, as well as materials and waste management. The specific plant design and procedural peculiarities are leading to an above-average input and hence cost for the WAK project. It is currently expected to be completed by the year 2014.

## Section E. <u>Legislative and Regulatory System</u>

### Article 18 (Implementing measures)

*Article 18*

*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.*

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.

### Article 19 (Legislative and regulatory framework)

*Article 19*

*1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management.*

In accordance with its federal structure, the Constitution of the Federal Republic of Germany (Article 74 (1) 11a of the Basic Law [GG 49]) bestows upon the Federal Government the responsibility for legislation and regulation regarding "the production and utilisation of nuclear energy for peaceful purposes, the construction and operation of facilities serving such purposes, protection against hazards arising from the release of nuclear energy or ionising radiation, and the disposal of radioactive substances."

The Atomic Energy Act (AtG) [1A-3] entered into force on 23 December 1959 immediately after the Federal Republic of Germany had declared its intention to renounce the use of nuclear weapons. One of the aims of this Act was to promote the peaceful use of nuclear energy. The country's renouncement of nuclear weapons was also formalised by signing the Non Proliferation Treaty (NPT) on 28 November 1969.

In Germany, legislation and the implementation thereof must also take account of all binding requirements arising from European Union regulations. With respect to radiation protection, these include the EURATOM Basic Safety Standards [1F-18] for the protection of the health of workers and the general public against the dangers arising from ionising radiation issued on the basis of Articles 30 ff. of the EURATOM Treaty [1F-1]. In accordance with Articles 77 ff. of the EURATOM Treaty, any utilisation of ores, source material and special fissile material is subject to the surveillance of the European Atomic Energy Community. Regarding nuclear liability, the Federal Republic of Germany is also a contracting party of

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

*Article 19*

*2. This legislative and regulatory framework shall provide for:*

*Article 19 2.*

*(i) the establishment of applicable national safety requirements and regulations for radiation safety;*

**Acts and Ordinances, in particular, the Atomic Energy Act**

The Atomic Energy Act [1A-3] comprises the general national regulations for the safety of nuclear installations in Germany and constitutes the basis for the associated ordinances. Its purpose 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 execution of the administrative tasks under the terms of the Atomic Energy Act is performed by the *Länder* (Federal States) as agents of the Federal Government (federal executive administration). This means that in executing the Atomic Energy Act and its associated ordinances, the *Länder* are under the supervision of the Federal Government with regard to the lawfulness and expediency of their actions.

The competent authority for nuclear safety and radiation protection is the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). In this role, the BMU also sees to that the Länder fulfil their licensing and supervisory functions according to the same standards. The *Länder* Committee for Nuclear Energy, which convenes competent representatives from federal and regional levels for regular meetings, serves as a further instrument for harmonisation of the associated activities.

Interpretation of the term “state of the art in science and technology”, which is prescribed as the required yardstick in the Atomic Energy Ac, ensures that safety standards are adapted in line with modern developments. This is a more stringent requirement than the "state of the art" demanded elsewhere in German technical safety legislation or than the even less demanding "generally recognised engineering rules".

A number of ordinances have also been promulgated in the field of nuclear energy on the basis of the Atomic Energy Act relating to the management of spent nuclear fuel and the management of radioactive wastes. The most important ones pertain to:

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

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

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

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

**General Administrative Provisions**

Beneath the level of acts and ordinances, general administrative provisions contain binding regulations governing the actions of the authorities. With respect to nuclear technology, there are a number of provisions governing:

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

**Guidelines**

Guidelines are issued by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) following consultations with the *Länder* (Federal State) and generally by way of consensus with them. These guidelines are designed to provide a detailed specification of selected technical and administrative issues arising from the licensing and supervisory procedure (cf. the remarks on Article 20 of the Convention). They outline the BMU's opinion on general issues relating to nuclear safety and administrative practice, and provide orientation for the authorities of the *Länder* (Federal States) in their execution of the Atomic Energy Act. However, unlike general administrative provisions, these guidelines are not binding for the authorities of the *Länder* (Federal States). There are currently some 50 guidelines in the field of nuclear technology. (The part which also applies to the treatment of spent fuel assemblies and radioactive waste can be found in Appendix L-(f) [3-1] and following).

The following guidelines are of importance exclusively to the management of spent nuclear fuel and radioactive waste:

- the Safety Guidelines for Dry Interim Storage of Irradiated Fuel Assemblies in Storage Casks [4-2],
- the Safety Criteria for the Permanent Storage of Radioactive Wastes in a Mine [3-13],
- the Guideline on the Monitoring of Emissions and Immissions Resulting from Nuclear Facilities [3-23],
- the Guideline on Control of Radioactive Wastes with Negligible Heat Production Not Delivered to a State Collecting Facility [3-59],
- the Guide to Decommissioning of Facilities under Section 7 of the Atomic Energy Act (AtG) [3-73].

**Recommendations of the RSK and SSK**

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

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

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

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

**KTA Safety Standards**

The Nuclear Safety Standards Commission (KTA), founded in 1972, formulates regulations containing detailed, concrete specifications of a technical nature. Such regulations are produced wherever "experience leads to a uniform opinion among experts from within the groups of manufacturers, construction companies, and licensees of nuclear installations, together with expert organisations and the authorities." Each of these groups is represented in the KTA. Regular reviews and amendment where necessary of adopted safety standards at intervals of no more than five years ensure that standards are adapted in line with the state of the art in science and technology. In themselves, KTA safety standards are not legally binding. However, by virtue of their process of origination and their high level of detail, their practical effect is wide-ranging. To date, the KTA has issued a total of 90 safety standards and 2 standard drafts (as at 11/04); an additional 10 standard drafts are currently under preparation, and 30 safety standards are in the process of being revised. Most of these standards refer to nuclear power plants, although some also apply analogously to facilities for spent fuel and radioactive waste management.

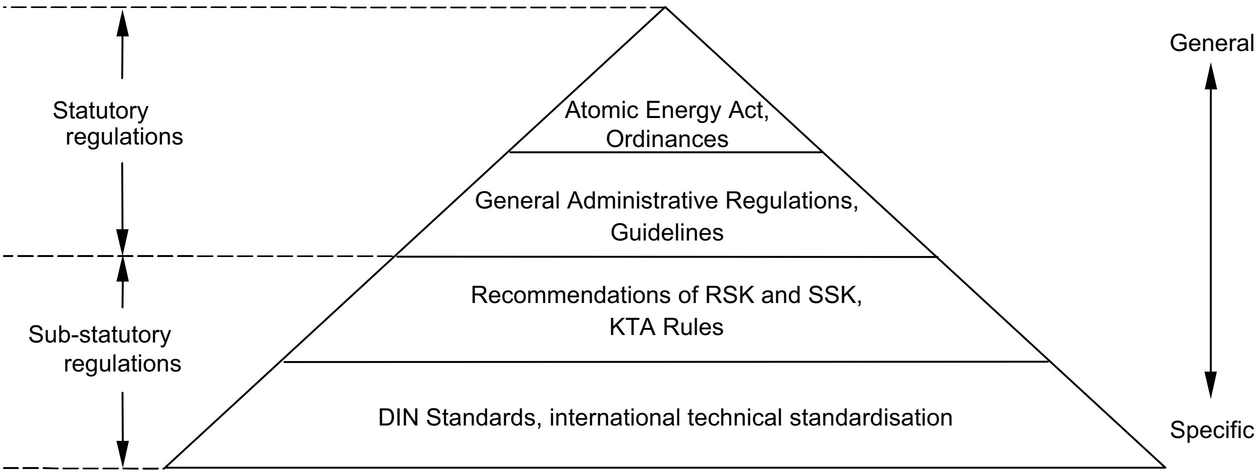
Quality assurance is a key issue, and one which is addressed in most of the safety standards. The term quality assurance as used in the KTA safety standards also encompasses the area of ageing, which is now treated as a separate issue at international level (cf. the remarks on Article 23 of the Convention).

**Conventional Technical Standards**

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

**Overall Picture of Nuclear Rules and Regulations**

Overall, German nuclear safety regulations may be hierarchically structured in the form of a pyramid.




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

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

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

**Other Legal Areas**

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

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

- the Environmental Impact Assessment Act (*Gesetz über die Umweltverträglichkeitsprüfung*) [1B-14].

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

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

*Article 19 2.*

*(ii) a system of licensing of spent fuel and radioactive waste management activities;*

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

- Section 7 of the Atomic Energy Act (AtG): The management of spent nuclear fuel and radioactive wastes within stationary facilities 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 facilities under Section 7 of the AtG, provided these management phases are directly related to the purpose of the facility. This applies in particular to the storage of spent fuel assemblies in the cooling pond of the reactor and to the treatment and interim storage of operational wastes. The pilot conditioning plant (PKA) at Gorleben, whose primary purpose is the treatment of spent fuel assemblies, likewise falls under the licensing requirement pursuant to Section 7 of the AtG. Licensing and supervision of the plant are carried out by the competent authority in the *Land (*Federal State) where the facility is located; in the case of the PKA, this is the *Land* of Lower Saxony.
- Section 3 of the AtG: The import and export of nuclear fuel requires a permit under Section 3 of the AtG. A decision on the application is made by the Federal Office of Economics and Export Control (BAFA). The supervision of imports and exports is the responsibility of the Ministry of Finance or designated customs offices.
- Section 6 of the AtG: The storage of nuclear fuel, including spent fuel assemblies and radioactive wastes with significant contents of fissile material, requires a licence under Section 6 of the 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 licensing authority in this instance is the Federal Office for Radiation Protection (BfS), whilst supervision is performed by the competent authority of the respective *Land*.
- Section 9 of the AtG: The treatment, handling and other use of nuclear fuel outside of the facilities specified in Section 7 of the AtG, e.g. the handling of nuclear fuel on a laboratory scale for research purposes, requires an authorisation under Section 9 of the AtG. The respective *Land* is responsible for licensing and supervision of the facility.
- Section 9b of the AtG: The securing and disposal of radioactive wastes, which is the responsibility of the Federal Government according to the Atomic Energy Act, requires plan approval under Section 9b of the AtG. The nuclear plan approval authority responsible is the competent supreme *Land* authority of the respective Federal State. Plan approval is required for the repository site, a process which differs significantly from a licensing procedure under Sections 6 or 7 of the AtG in a number of respects. The applicant and subsequent operator is the Federal Office for Radiation Protection. According to Section 9a of the AtG, the Federal Government may avail itself of the services of third parties or may transfer the execution of its tasks with the

necessary sovereign competencies either wholly or partially to third parties, provided their proper fulfilment is guaranteed. These activities are subject to federal government supervision.

- Section 9c of the AtG: The licensing provisions of the 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 State collecting facilities.
- Section 7 of the Radiation Protection Ordinance (StrlSchV): The handling of radioactive wastes requires a licence under Section 7 of the StrlSchV, unless already covered by one of the licences mentioned above. This category includes, in particular, the waste collecting facilities of the *Länder* (Federal States), and interim storage facilities for radioactive wastes at research centres and conditioning facilities. Licensing and supervision are the responsibility of the competent authorities of the *Länder* (Federal States).

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

Responsibilities relating to the licensing of nuclear installations are summarised in Table E-1

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

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

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

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

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

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

The licensing of nuclear installations (except for nuclear fuel storage facilities licensed by the BfS under Section 6 of the AtG) is the responsibility of the individual *Länder* (Federal States). In each of the *Länder,* ministries are the supreme authorities responsible for licensing. The Federal Government supervises implementation of the Atomic Energy Act and Radiological Protection Regulations (federal supervision). In particular, it has the right to issue binding directives on factual and legal issues in each individual case.

The actual details and procedure of licensing in accordance with Section 7 of the AtG are specified in the Nuclear Licensing Procedures Ordinance [1A-10]. It deals specifically with the application procedure, the submission of supporting documents, participation of the general public and the option of splitting the procedure into several stages (partial licences). Furthermore, it also addresses the assessment of environmental impacts [1B-14] and the consideration of other licensing requirements (e.g. non-radioactive emissions into the air or discharges into water). In the case of other nuclear licensing and plan approval procedures (according to Sections 6 or 9b of the AtG), the Nuclear Licensing Procedure Ordinance is applied analogously. The option of splitting the licensing procedure into several stages (with individual partial licences) is usually taken up for large-scale facilities which take longer to build. The advantage is that the most recent state of the art in science and technology can be applied in each individual procedural step. For example, the first step may include the licensing of the site, the safety concept and the most important structures. Further steps might be the installation of safety-relevant systems, nuclear start-up, and full power operation.

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

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

**<u>The Nuclear Licensing Procedure as Illustrated by the Example of the Procedure According to Section 7 of the AtG</u>**

**Licence Application**

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

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

1. a safety report outlining the consequences of the project which are relevant to the decision on the application with regard to nuclear safety and radiation protection, and which will enable third parties in particular to evaluate whether their rights could be violated by the facility or the impacts resulting from its operation. For this purpose, as far as this is necessary for a judgement of the project’s admissibility, the safety report must include the following information:
   a) a description of the facility and its operation including site plans and drawings;
   b) a description and explanation of the concept (basic design features), the safety relevant design principles, and the function of the facility including its operational and safety systems;
   c) an outline of the precautionary measures taken to meet the requirements of Section 7, para. 2, subpara. 3 and Section 7, para. 2a of the Atomic Energy Act (AtG), i.e. precautions against damage caused by the erection and operation of the facility in accordance with the state of the art in science and technology, including an explanation of the measures taken to prevent or mitigate the consequences of accidents not covered by the design of the facility and their tasks;
   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 Sections 49 and 50 of the Radiation Protection Ordinance (StrlSchV) (design basis accidents);
   f) a description of the impacts of direct radiation and the emission of radioactive substances referred to under e) on the protected entities outlined in Section 1a of the Nuclear Licensing Procedures Ordinance; these are human beings, animals and plants, soil, water, air, climate and landscape, cultural assets and other entities, including interactions with other substances;
2. complementary schemes, drawings and descriptions of the facility and its parts;
3. information on the provisions to protect the facility and its operation against malevolent acts or other illegal interference by third parties in accordance with Section 7, para. 2 subpara. 5 of the AtG;
4. information which will enable verification of the reliability and technical knowledge of the persons responsible for erection of the facility and for management and supervision of its operation;
5. information which will enable verification of the existence of the necessary knowledge of other persons involved in the operation of the facility in accordance with Section 7, para. 2, subpara. 2 of the AtG;
6. a list of all information relevant to the safety of the facility and its operation, the precautions taken for the control of accidents and damages, and a framework plan for the checks foreseen at safety-relevant parts of the facility (safety specifications);
7. proposals on precautions to comply with obligations on statutory liability for damages;

8. a description of the amounts of radioactive residues and information on precautions taken
   a) to avoid accumulation of radioactive residues;
   b) for the non-hazardous utilisation of radioactive residues and removed or dismantled radioactive components;
   c) for the orderly disposal of radioactive residues or removed radioactive components as radioactive waste, including their intended treatment, and for the anticipated storage of radioactive wastes until their disposal;
9. information on other environmental impacts of the project required for verification pursuant to Section 7, para. 2, subpara. 6 of the AtG for any approval decisions included in the licensing decision in individual cases, or for any decisions to be made by the licensing authority according to regulations on nature protection and landscape conservation. On this basis, it is necessary to verify that there are no overwhelming public interests, in particular with regard to environmental impacts, opposed to the choice of the site for the facility.

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

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

Within the framework of federal executive administration, the licensing authority of the individual *Land* (Federal State) may receive an opinion from the Federal Environment Ministry (BMU) from the point of view of federal supervision before the licence is granted. In performing its function of federal supervision, the BMU consults the Reactor Safety Commission, the Commission on Radiological Protection, and in many cases the *Gesellschaft für Anlagen- und Reaktorsicherheit,* for advice and technical support, and states its position on the draft licence to the competent licensing authority. The *Land* licensing authority must take the BMU's position into account when making its decision.

**Participation of the General Public**
The licensing authority involves the general public in the licensing procedures, including in particular those citizens who might be affected by the planned facility. Details are regulated in the Nuclear Licensing Procedures Ordinance (AtVfV) [1A-10].

According to Section 4 of the AtVfV, the project is published in the official Publication Gazette and in local newspapers once the documents to be submitted are complete. According to Section 5 of the 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 Section 6 of the AtVfV, the application, the safety report, a short description of the project, information on radioactive residues and other environmental impacts of the project, as described under points 8 and 9 above, are to be laid out for public inspection over a period of two months.

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

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

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

**Environmental Impact Assessment**

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

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

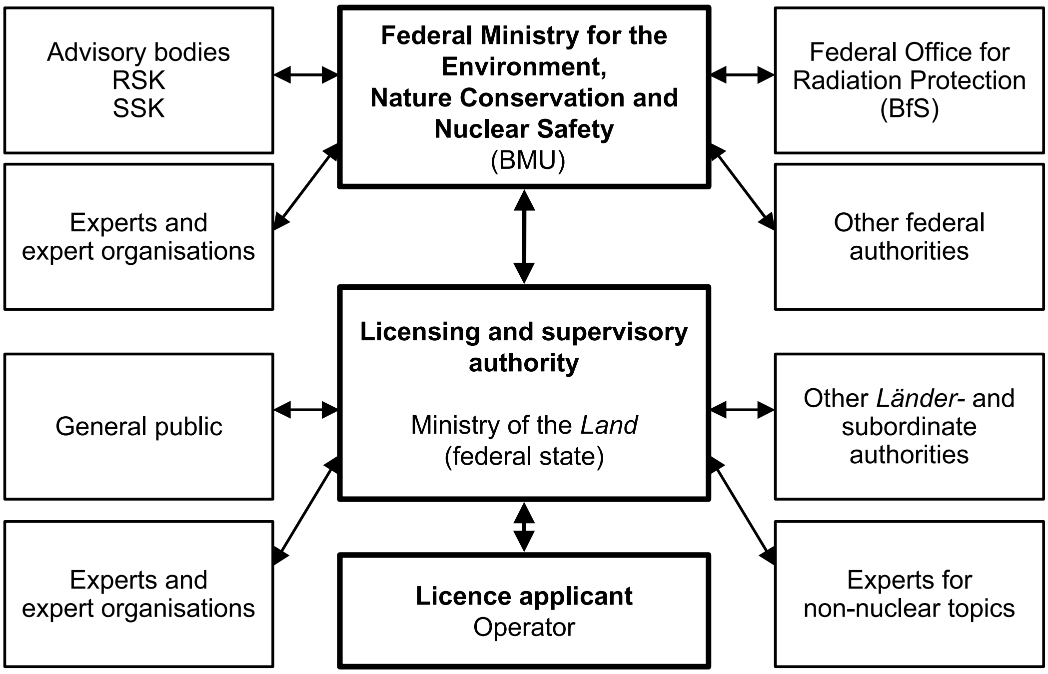
The competent authority performs a final evaluation of the environmental impacts which provides the basis for a decision on the project's admissibility with regard to effective environmental protection.

**Licensing Decision**

The final decision of the licensing authority is based on the entirety of application documents, evaluation reports by the authorised experts, the opinion of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, the opinions of the authorities involved, and the findings from objections raised in the public hearing. One prerequisite for the legality of this decision is that all procedural requirements of the Nuclear Licensing Procedures Ordinance must have been observed. Action may be brought against the decision of the licensing authority before the administrative courts. In the case of a licence with immediate enforcement, a court action cannot prevent use being made of the licence.

The interaction between the various authorities and organisations involved in the nuclear licensing procedure and the participation of the general public is shown in Figure E–1.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–1: Parties involved in the nuclear licensing procedure (using the procedure according to Section 7 of the AtG as an example)




**Plan Approval Procedure**

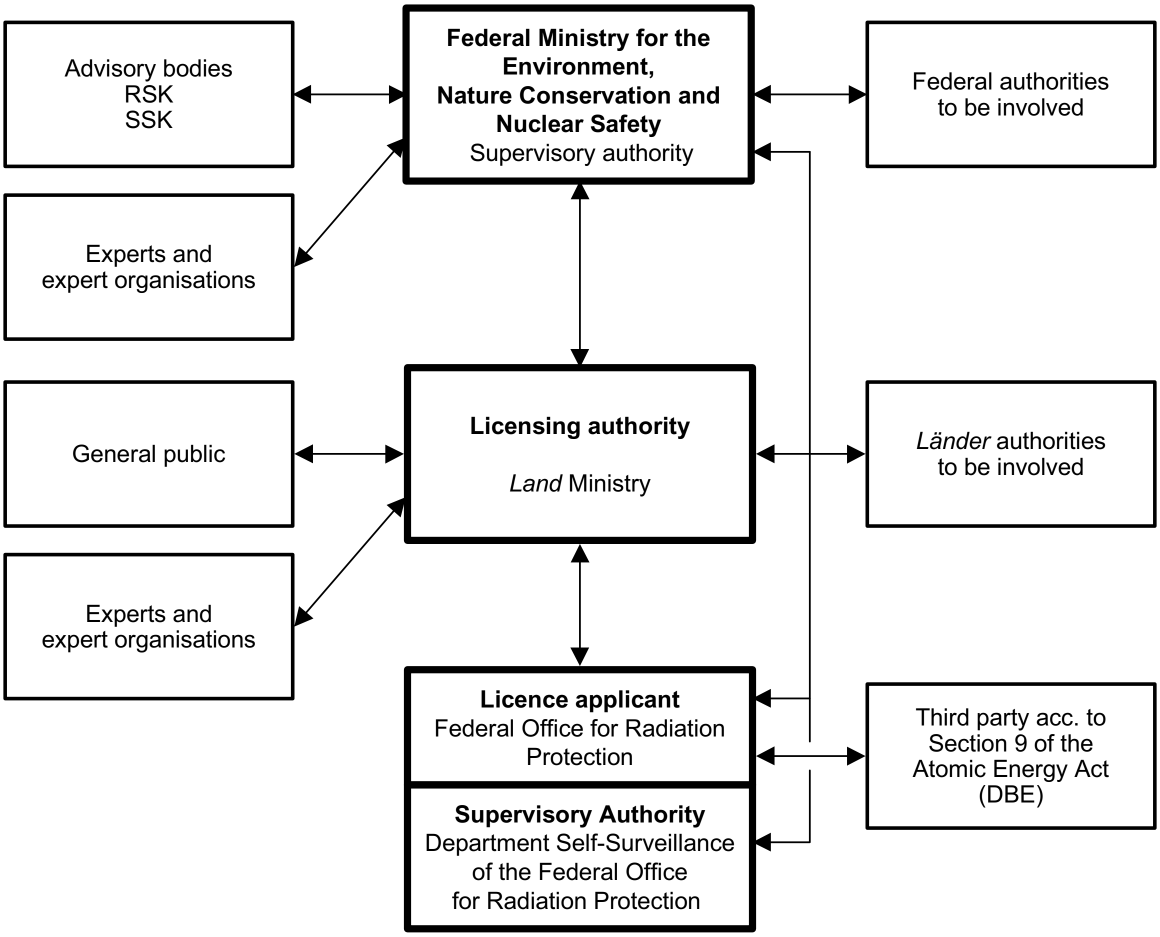
According to Section 23, para. 1, subpara. 2 of the Atomic Energy Act (AtG), the Federal Office for Radiation Protection (BfS) is responsible for the construction and operation of facilities for the safekeeping and disposal of radioactive wastes. According to Section 9a, para. 3 of the AtG, the BfS may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

According to Section 9b of the AtG, the construction and operation of radioactive waste repositories requires a special licence known as plan approval (*Planfeststellung*). The requirements for this licence are very similar to those for a procedure under Section 7 of the AtG. The only exception is the requirement for liability provisions, which does not apply in the case of radioactive waste repositories since the state itself is responsible for such facilities. Section 13, para. 4 of the AtG explicitly states that the Federal Government and the *Länder* (Federal States) are not obliged to make liability provisions. Even if all requirements are met, the licensing authority is under no obligation to grant a licence. The licence must not be granted if unavoidable impairments to the common good are to be expected as a result of the construction or operation of the facility, or if other regulations under public law are opposed to the construction or operation of the facility. The licensing authority is also obliged to examine the justification of the project.

The main peculiarity of the plan approval procedure for radioactive waste repositories is that all legal areas are concentrated within one single procedure. As such, unlike other nuclear licensing procedures, the licence incorporates all the other licences required, e.g. under the terms of water legislation, building legislation or nature conservation legislation. According to Section 9b, para. 5, subpara. 3 of the AtG, there is only one exception, namely, that plan approval does not cover the legitimacy of the project under the provisions of mining law. This aspect must be decided by the competent authority. The participants in a plan approval procedure for radioactive waste repositories are shown in Figure E–2.

In exercising its tasks, the BfS performs a twofold function. On the one hand, the office is the applicant in a plan approval procedure according to Section 9b of the AtG; on the other, it performs a self-supervisory role during the construction and operation of a radioactive waste repository ("self-surveillance"). Self-surveillance is a separate organizational unit within the BfS and is subject to the direct supervision of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

Figure E–2: Participants in a plan approval procedure for a radioactive waste disposal facility




*Article 19 2.*

*(iii) a system of prohibition of the operation of a spent fuel or radioactive waste management facility without a licence;*

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).

*Article 19 2.*

*(iv) a system of appropriate institutional control, regulatory inspection and documentation and reporting;*

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

In the case of nuclear installations or the use of nuclear fuel licensed under Section 6, 7 or 9 of the AtG, the *Länder* (Federal States) in their supervisory role are acting on behalf of the Federal Government. In other words, the Federal Government has the right to issue binding directives on factual and legal issues in each individual case. As in the licensing procedure, the *Länder* are assisted by independent authorised experts.

As in licensing, the supreme objective of government supervision of nuclear installations 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 ancillary provisions imposed by the licensing notices,
- compliance with the requirements of the Atomic Energy Act, the nuclear ordinances and other nuclear safety standards and guidelines, and
- compliance with any supervisory orders issued.

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

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

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

Contrary to the standard practice for nuclear installations licensed under Sections 6, 7 or 9 of the AtG, the regulations governing the supervision of radioactive waste repositories once a licence has been issued are somewhat different. In such cases, supervision is carried out by the Federal Government itself. To this end, an independent department – the so-called “Self-Surveillance” section – has been established within the Federal Office for Radiation Protection which performs government supervisory tasks on behalf of the Federal Government in co-operation with the responsible Federal Ministry (technical and legal supervision) (cf. the remarks on Article 20 2).

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

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

In Sections 72 and 73 of the StrlSchV, the plant operators 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. A further development 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. 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 Section 9a para 1 AtG. In particular, it has to be shown that adequate provisions to fulfil these obligations have been made for already existing and for future arising spent fuels as well as for the waste to be taken back from reprocessing (Section 9a, para. 1a). This proof has to be provided annually. For the orderly disposal of the spent fuel as well as of the radioactive waste from reprocessing, it has to be shown that safe storage in interim storage facilities is ensured until their final disposal in a repository (Section 9a, para. 1b). Realistic plans have to be submitted with regard to the expected need for interim storage capacity. The availability of the expected interim storage capacity that is needed has to be demonstrated for the following two years. If the non-hazardous re-use of the plutonium from reprocessing is intended, it also has to be shown that the re-use of the plutonium in the nuclear power plants is ensured (Section 9a, para. 1c). This proof has been furnished if realistic plans for processing, fuel assembly fabrication and fuel assembly use have been provided and their feasibility has been demonstrated. As for the uranium from reprocessing, its safekeeping has to be demonstrated by realistic planning of sufficient interim storage capacities (Section 9a, para. 1d).

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

All safety-related events in facilities licensed according to Sections 6 and 7 AtG have to be reported to the authorities in accordance with the AtSMV [1A-17]. A corresponding reporting obligation for other plants ensues from Section 51 StrlSchV. The regulations and procedures relating to reportable events and their evaluation are described in the remarks on Article 9.

*Article 19 2.*

*(v) the enforcement of applicable regulations and of the terms of the licences;*

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

**Criminal Offences**

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

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

is liable to imprisonment or fines.

**Administrative Offences**

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

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

The Atomic Energy Act and related ordinances require that the individuals who are ultimately responsible for the handling of radioactive material, for the operation of nuclear installations or for their supervision should be named. A person committing an administrative offence is personally liable for a fine up to € 50000. A legally effective fine against a person may cast doubt on the personal trustworthiness that was a prerequisite for the licence and may therefore require the removal of such individuals from office (cf. the remarks on Article 21 of the Convention).

**Enforcement by Regulatory Order, Particularly in Urgent Cases**

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

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

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

**Enforcement by Modification or Revocation of the Licence**

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

*Article 19 2.*

*(vi) a clear allocation of responsibilities of the bodies involved in the different steps of spent fuel and of radioactive waste management.*

The management of spent fuel assemblies and radioactive waste is based on the polluter-pays principle. According to Section 9a, para. 1 of the AtG, the producers are required to ensure their non-hazardous recycling or their orderly disposal as radioactive waste. This also means that the producers are responsible for the conditioning and interim storage of the spent fuel assemblies and the radioactive waste.

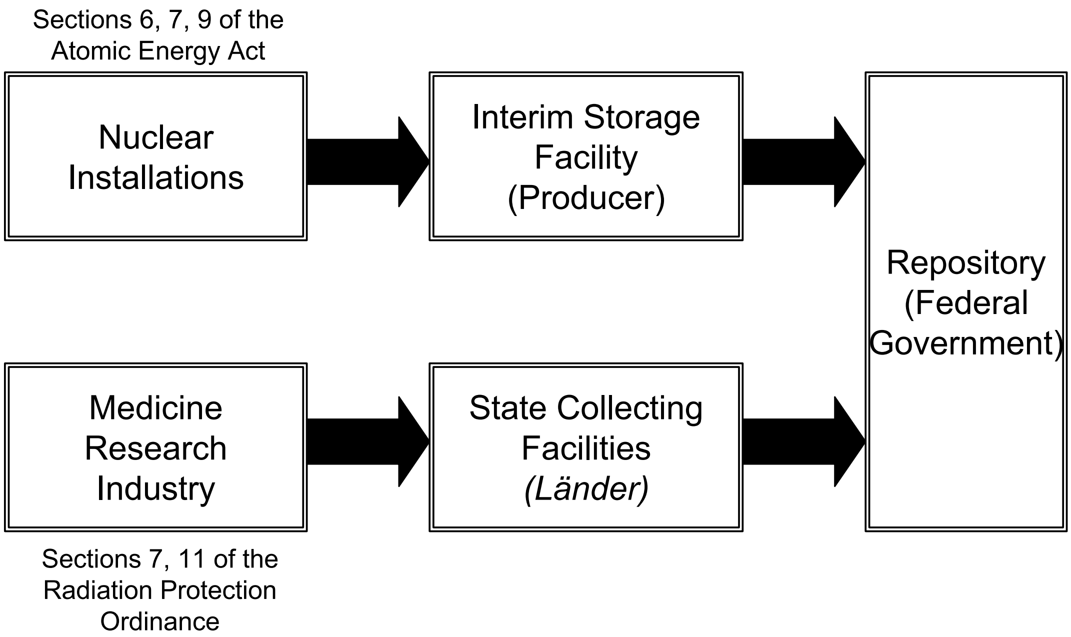
According to Section 9a, para. 2 of the AtG, as a general principle, anyone possessing radioactive waste must deliver it to a repository or to a State collecting facility (cf. Figure E–3).

According to Section 9a, para. 3 of the AtG, the *Länder* (Federal States) are required to establish State collecting facilities for the storage of radioactive wastes arising within their territory.

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

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

Figure E–3: Obligation for the delivery of radioactive wastes and responsibilities (diagrammatic representation)




**Article 20 (Regulatory body)**

> *Article 20*
>
> *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.*

**Competence and authority**

The Federal Republic of Germany is a federal state (Art. 20 (1) of the Basic Law (GG) [GG 49]), in which the individual *Länder* (Federal States) have the right of legislation except where specifically allocated to the Federal Government in the Basic Law (Art. 70 (1) of the GG). One special case concerns the area of competing legislation, where the *Länder* have the right of legislation provided the Federal State does not make use of its competence (Art. 72 (1) of the GG). Nuclear Legislation falls into this category (Art. 74 (1) no. 11a of the GG).

In adopting the Act on the Peaceful Utilization of Atomic Energy and the Protection against its Hazards (Atomic Energy Act) on 23 December 1959, the Federal Government made use of this legislative competence. The Atomic Energy Act was comprehensively amended by an Amending Act dated 19 July 2002.

Statutory ordinances have been issued on the basis of this Act with the approval of the *Bundesrat* (Federal Council).

Section 19 of the Atomic Energy Act (AtG) outlines the provisions of governmental supervision which is executed by the *Länder*, with the exception of the supervision of repositories.

Governmental supervision extends to the handling and trafficking of radioactive materials, the construction, operation and ownership of stationary facilities for the production, processing, treatment or fission of nuclear fuels or the reprocessing thereof, as well as facilities for the production of ionising radiation (facilities of the type mentioned in Sections 7 and 11 (1), no. 2 of the AtG), the ising radiation (facilities of the type mentioned in Sections 7 and 11 (1), no. 2 of the AtG), the handling and trafficking of facilities, instruments and devices which contain radioactive materials or generate ionising radiation (facilities, instruments and devices of the type mentioned in Section 11 (3)), the transportation of such materials, facilities, instruments and devices, the appropriated addition of radioactive materials and the activation of materials, insofar as requirements in this respect exist under the AtG or by virtue of an ordinance based on this act, as well as all work with ionising radiation of natural origin (according to Section 11 (1) no. 7 of the AtG).

The *Länder* implement the Atomic Energy Act in accordance with Section 24 (1), page 1 of the AtG in connection with Art. 87 c of the GG on behalf of the Federal Government. In accordance with Art. 85 (3) of the GG, the consequence of this is that responsibility for supervision of the *Länder* with respect to the lawfulness and appropriateness of measures taken lies with the Federal Government.

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

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

- According to Section 22 of the AtG, the Federal Office of Economics and Export Control (BAFA) is responsible for licences involving transboundary transportation, while supervision is the responsibility of the Federal Ministry of Finances or the customs authorities designated by it.
- According to Section 23 of the AtG, the Federal Office for Radiation Protection (BfS) is responsible for the following with regard to the treatment of spent fuel assemblies and radioactive waste:
  - the construction and operation of federal facilities for the safekeeping and disposal of radioactive waste, the transfer of tasks to third parties by the Federal Government, and the supervision of such third parties,
  - the licensing of nuclear fuel storage outside of federal custody, where this does not constitute preparation or part of an activity subject to licensing under Sections 7 or 9 of the 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 (Section 9a (2) of the AtG).
- The Federal Office of Administration is responsible for decisions regarding preservation orders to secure sites for the disposal of radioactive waste (according to Section 9g of the AtG).
- Section 24 of the AtG regulates the competence of the *Länder* authorities:
  (1) The other administrative tasks under the Second Section and the resultant statutory ordinances are performed by the *Länder* on behalf of the Federal Government.
  (2) The supreme *Länder* authorities designated by the *Länder* governments are responsible for the licensing of nuclear facilities (pursuant to Sections 7, 7a and 9 of the AtG) and the withdrawal and revocation thereof, as well as for plan approval (pursuant to Section 9b of the AtG) and the reversal thereof as well as for the supervision of nuclear facilities (pursuant to Section 7 of the AtG) and the use of nuclear fuels outside these facilities. These authorities are usually supreme *Länder* authorities; licensing and supervision rest not inevitably in the same authority. 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.

**Finances and Human Resources**

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

*Article 20*

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 organizations are involved in both spent fuel or radioactive waste management and in their regulation.*

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

The only instance where a conflict of interests might be conceivable is in situations where financial promotion or the subsidising of scientific research occurs in the same government sector as the supervision of the corresponding nuclear facilities. However, at Federal Government level there is no such risk of a conflict of interests since functions are assigned to different departments.

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

The licensing procedure for such a federal repository takes the form of a so-called plan approval procedure, for which the supreme *Länder* authority designated by the respective *Land* government is responsible. In this case, the Federal Office for Radiation Protection is the applicant and as such is subject to the decisions taken by the licensing authority, just like a private individual. Federal supervision by the federal ministry responsible for nuclear safety takes the form of legal and expediency supervision. The corresponding *Länder* authority decides on plan approval at its due discretion.

The supervision of construction and operation following plan approval is carried out by the independent “Self-surveillance” organisational unit within the BfS. Any possible conflicts of interest have been precluded by the organisational separation of the organisational unit in charge of repository planning and the “Self-surveillance” unit in charge of supervision. Although “Self-surveillance” is an organisational unit of the BfS, it is independent and not subject to directives. The unit's staff has no other functions. “Self-surveillance” is subject to the direct supervision of the BMU.

## Section F. Other General Safety Provisions

### Article 21 (Responsibility of the licence holder)

*Article 21*

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.*

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

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

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

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

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

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

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

*Article 21*

*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.*

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.

In cases where the licence holder is unable to meet his responsibility for safety with regard to the handling of nuclear fuels, or a corresponding licence does not exist, the Federal Government shall assume responsibility. Such a situation may also arise if nuclear fuels are found or in case of loss of authorisation on the part of the private licensee (e.g. in case of insolvency of the former owner or revocation of the licence). According to Section 5, para. 3 of the Atomic Energy Act (AtG), in such cases the Federal Government shall temporarily take the nuclear fuels into its charge ("government custody") from the private licensee until the prerequisites for the handling of these materials according to the nuclear rules and regulations have been met once again. However, if otherwise provided by the supervisory authority under Section 19, para. 3 of the AtG, then this provision shall have priority over government custody.

If there is no licence holder or other party responsible for management or storage facilities for radioactive wastes not containing nuclear fuel, 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* (Federal State).

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

## Article 22 (Human and financial resources)

*Article 22*

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

*Article 22*

*(i) qualified staff are available as needed for safety-related activities during the operating lifetime of a spent fuel and a radioactive waste management facility;*

The Federal Republic of Germany has created a framework of minimum standards of education and knowledge for employees at nuclear facilities. According to Section 7, para. 2, nos. 1 and 2 of the Atomic Energy Act (AtG) [1A-3], a licence for the erection or operation of a facility may only be granted if

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

Section 30 of the Radiation Protection Ordinance (StrlSchV) contains regulations concerning the required scope of expert knowledge in the field of radiation protection as well as its acquisition and conservation.

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

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.

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

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

- Group 1: A completed education at a university, college or technical college in a relevant technical or mathematical-scientific area is required for radiation protection supervisors. 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.
- Group 2: 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.
- Group 3: Section 31, para. 4 of the Radiation Protection Ordinance (StrlSchV) stipulates that proof is required that radiation protection officers who are appointed by the radiation protection supervisor according to section 31, para. 2 of the 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.
- Group 4: The fourth 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.

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 installations. The state, in the form of the Federal Government and the *Länder* (Federal States), provides educational facilities at which qualified vocational training is given. 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 installations, both state-owned and privately owned, for their part advertise for qualified staff.

There are appropriate training opportunities available in Germany at 17 universities and 11 technical colleges, for example in the field of nuclear and reactor technology at Aachen, Berlin, Essen, Karlsruhe, Munich and Zittau universities. Recognised radiation protection courses are held e.g. at FZK in Karlsruhe, at GSF in Munich and at Ilmenau Technical University. There are also recognised courses available in the non-governmental sector, e.g. at the various Chambers of Industry and Commerce and at *Haus der Technik* in Essen.

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

- In relation to individuals, this is ensured by the regulations on recurring training in the field of radiation protection. Instruction courses are held every six months 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.
- The "Alliance for Competence in Nuclear Technology within the Framework of the HGF Nuclear Technology Research Pool" (*Kompetenzverbund Kerntechnik im Rahmen des HGF-Forschungsbereiches Energie*) has been founded in order to maintain an adequate level of know-how in the nuclear and radiation protection sector. It consists of the Karlsruhe Research Centre together with the universities of Karlsruhe and Stuttgart, the Jülich Research Centre together with the Aachen RWTH (university) and the Aachen/Jülich technical college, the Rossendorf Research Centre together with Dresden technical university and Zittau/Görlitz technical college and the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS mbH) together with Munich Technical University. This competence pool analyses the education and training situation and provides forecasts for the future, aimed at clarifying the current training situation.

*Article 22*

*(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;*

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 Section 19 of the Atomic Energy Act (AtG). Governmental supervision takes into account the requirements as set out in Section 7 of the AtG.

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

*Article 22*

*(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.*

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.

## Article 23 (Quality assurance)

*Article 23*

*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.*

### Quality Assurance

The concept and design of facilities for the conditioning, interim storage and disposal of spent fuel assemblies and radioactive waste include constructive and administrative measures designed to protect the general public and workers against hazards arising from the release of radioactive substances and ionising radiation. The effectiveness of these measures is ensured within the framework of a quality assurance programme which also considers ageing phenomena and preventive maintenance. The KTA Nuclear Safety Standard 1401 of the Nuclear Safety Standards Commission specifies general requirements for quality assurance regarding nuclear power plants. These requirements of the Safety Standard are applied wherever relevant. These include the principles of operational organisation, planning and design, production and construction including quality control, specified normal operation and incidents, documentation and archiving, as well as auditing of the quality assurance system itself. One essential element of quality assurance is the operating manual. The nature and scope of measures to safeguard quality characteristics are oriented towards their significance for preventing damages caused by radiation exposure. The applicant or licensee is responsible for the planning, performance and control of the effectiveness of quality assurance. In this respect, an essential requirement of KTA Nuclear Safety Standard 1401 is the technical knowledge and qualification of the personnel.

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

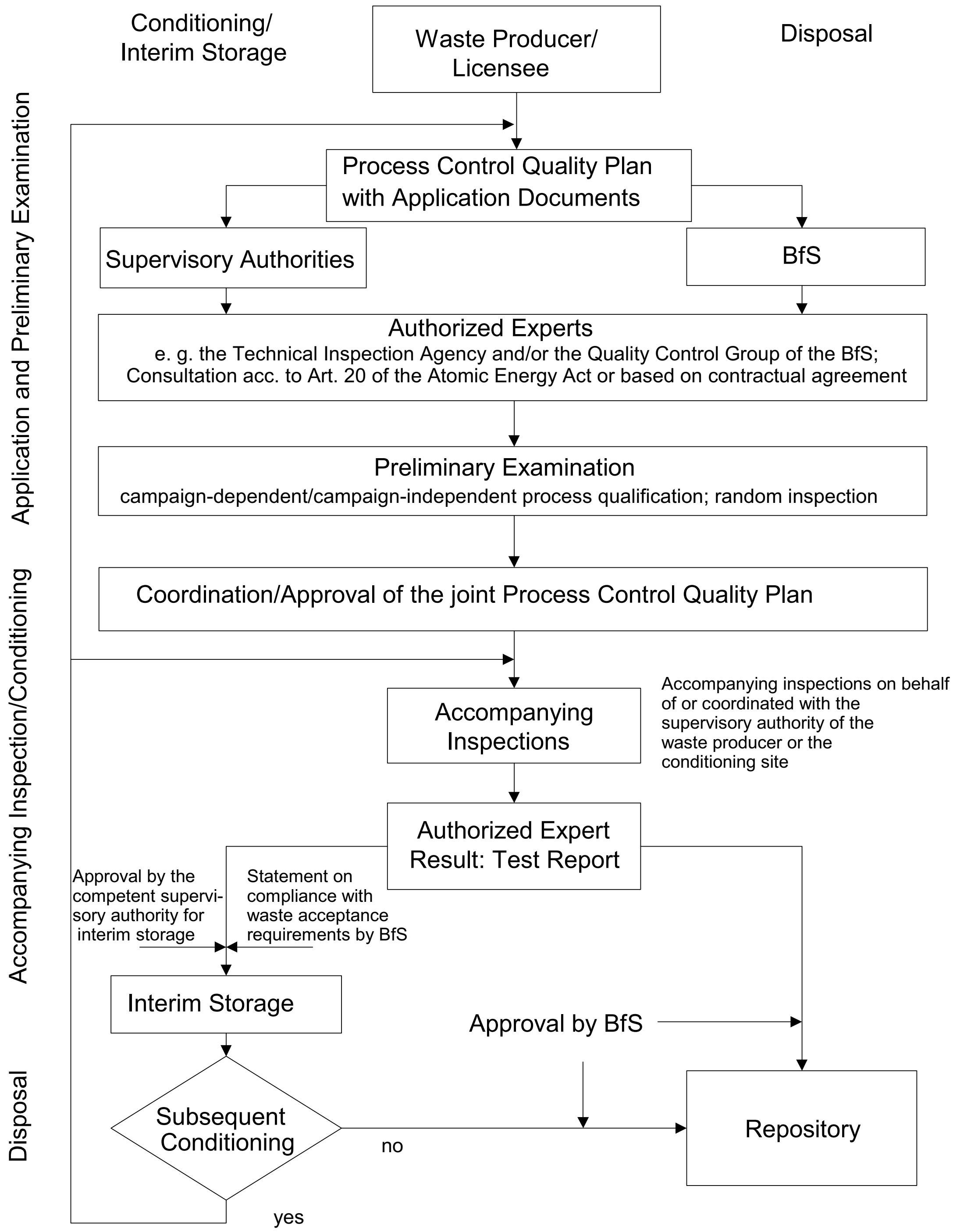
Some quality assurance requirements in international standards, e. g. in DIN ISO EN 9001 and DIN EN 45004, are not addressed by KTA 1401. However, AtG and StrlSchV generally require compliance with the state of the art in science and technology. It is thus ensured that quality assurance requirements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

### Waste Package Quality Control

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

Waste package quality control comprises regulations on quality assurance in the registration and conditioning of radioactive waste and in the production of waste containers, including the registration and documentation of the repository-relevant characteristics of the waste packages. Organisational and administrative regulations governing the spheres of responsibility, tasks and activities of the parties involved are laid down in a decision by the main committee of the *Länder* (Federal States) Committee for Nuclear Power, a body of the nuclear authorities, of 1/2 December 1994 (cf. Figure F–1) 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, 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–1: Quality control procedure for radioactive waste packages from nuclear facilities with respect to their conditioning, interim storage and disposal



## Regulations on Waste Package Quality Control

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

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

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

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

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

## Article 24 (Operational radiation protection)

*Article 24*

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:*

*Article 24 1.*

*(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;*

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 StrlSchV 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 State Collecting Facility” (*Directive 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 were also incorporated, together with a number of other regulations.

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

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

**Radiation Exposure of Occupationally Exposed Individuals**

Individuals exposed to radiation by virtue of their occupation are monitored for their radiation exposure by means of official and company dosimeters. According to the Radiation Protection Ordinance, they must not receive an effective dose of more than 20 mSv in a calendar year. In individual cases, up to 50 mSv in a year may be permitted, but the total dose over five years must not exceed 100 mSv. Limits are also specified for individual organ doses. Further details can be found in Table F-1.

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

Furthermore, women of child-bearing age must not receive a cumulative dose of more than 2 mSv per month to the womb.

For a foetus whose mother may continue working in the controlled area after her pregnancy has become known, the limit is 1 mSv if an incorporation of radioactive materials can be excluded.

The maximum effective dose permitted over an individual's entire working life is 400 mSv.

The aforementioned dose limits may only be exceeded in exceptional cases for which official authorization 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). 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 Section 54 of the Radiation Protection Ordinance; this must be repeated every two years.

In keeping with the requirements of the StrlSchV, the protection of persons subject to on-site and off-site radiation exposure by virtue of their occupation has already been taken into account in the conceptual design of the nuclear facility, and must be ensured during its operation by appropriate protective measures and protective clothing, especially when handling open radioactive materials. For work to be carried out in the restricted-access areas, radiation protection instructions are specified as part of the preparation of the work so that the time of the employee staying within the restricted-access area is kept as short as possible and radiation protection is thus optimised. Sections 36 to 45 StrlSchV deal primarily with the radiation protection of the personnel. The working conditions for pregnant women must be designed in such a way as to preclude internal radiation exposure.

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

The radiation protection supervisor and the radiation protection officers must no be hindered from fulfilling their duties or be discriminated against as a result. The radiation protection officer ensures as part of work preparation that the stay of staff within the restricted-access area is kept as short as possible. If necessary, he checks the measures taken for this purpose himself. He stipulates the required radiation protection measures and their verification and supervises and documents these. He ensures that all devices and equipment of relevance for radiation protection are regularly maintained and inspected. He instructs the personnel and makes sure that alarm exercises are carried out at regular intervals. Furthermore, he is concerned with the necessary plant-internal emergency measures. To ensure that the radiation protection officer has the competence necessary for his task in accordance with Section 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.

## Radiation Exposure of the General Population

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

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

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

| § | Scope of application | Period | Limit [mSv] |
|---|---|---|---|
| | **Dose limits for persons exposed by virtue of their occupation** | | |
| **55** | Persons exposed by virtue of their occupation | | |
| | Effective dose | Calendar year | 20 |
| | Organ dose for the lens of the eye | Calendar year | 150 |
| | Organ dose for skin, hands, forearms, feet, and ankles | Calendar year | 500 |
| | Organ dose for gonads, womb, and red bone marrow | Calendar year | 50 |
| | Organ dose for thyroid gland and bone surfaces | Calendar year | 300 |
| | Organ dose for large intestine, lung, stomach, bladder, chest, liver, oesophagus, thyroid gland, and other organs or tissue not named above | Calendar year | 150 |
| | Body dose for persons under the age of 18 | Calendar year | 1 |
| | Apprentices aged 16-18, with the permission of the government agency | Calendar year | 6 |
| | Partial body dose for womb for women of child-bearing age | Month | 2 |
| | Unborn child | Pregnancy | 1 |
| **56** | Occupational lifetime dose, effective dose | Whole lifetime | 400 |
| **58** | Elimination of the consequences of hazardous incidents (Category A only, after authorization by the authority) | | |
| | 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 | 1000 |
| **59** | Averting dangers to people | Calendar year | 100 |
| | (over 18 years of age only, no pregnant women) | Once a lifetime | 250 |

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

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

On-site interim storage facilities and temporary storage facilities for spent fuel assemblies do not generate any discharges of radioactive waste water, since any contaminated waste water e.g. from maintenance work on the 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 and temporary storage facilities. In such cases, the aforementioned radiation-exposure limits for personnel and the general public must be taken into account.

Nuclear facilities not subject to licensing under Sections 6, 7 or 9 of the Atomic Energy Act, or to authorization by means of the plan approval process under Section 9b of the AtG, but which instead require a licence under Section 7 of the Radiation Protection Ordinance, such as conditioning facilities or interim storage facilities for radioactive wastes, do not require explicit specification of discharge values, provided the activity concentration levels listed in Appendix VII, Part D, of the StrlSchV are not exceeded on an annual average. Adherence to the requirements is regularly checked by the supervisory agency or appointed independent experts.

| *Article 24 1.* |
| --- |
| *(iii) measures are taken to prevent unplanned and uncontrolled releases of radioactive materials into the environment.* |

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

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

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

For all other nuclear facilities, such as the central interim storage facilities for spent fuel assemblies at Gorleben and Ahaus, the interim storage facilities for radioactive wastes, and conditioning facilities for spent fuel assemblies and radioactive wastes, Section 50 of the StrlSchV applies if certain amounts of radioactive materials handled are exceeded. For such nuclear facilities, structural or engineering safeguards are specified by the licensing agency according to the hazard potential and the probability of accidents at a given plant. Over the next few years, the Federal Government intends to issue general administrative rules on accident prevent for the design of such nuclear installations. As a transitional measure according to Section 117, para. 18 of the StrlSchV, an effective dose of 50 mSv has been set for the worst-case accident.

| *Article 24* |
| --- |
| *2. Each Contracting Party shall take appropriate steps to ensure that discharges shall be limited:* |

| *Article 24 2.* |
| --- |
| *(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.* |

**Discharges**

According to Sections 46 to 48 of the Radiation Protection Ordinance, radioactive substances may not be released into the surrounding environment of a nuclear facility in an uncontrolled fashion. Their operational discharge into water or air must be monitored, and registered according to specific type and activity. The discharge values specified by the competent authority in the plant's licence shall be observed with regard to concentration and quantity of radioactivity. As a rule, the actual values fall well below these limits.

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

With respect to minimization of dose levels, please refer the remarks on Article 24 1.

**Clearance of Material**

Whilst reporting within the context of Article 24 2. (i) and (ii) is confined to discharges from the normal operation of nuclear facilities, at this point we would also mention the release from control of residual materials from nuclear facilities or other authorized handling of radioactive material (clearance), given its particular significance for waste and residual-materials management. However, clearance of solid or liquid materials in accordance with Section 29 of the Radiation Protection Ordinance (StrlSchV) does not constitute a discharge within the meaning of the definitions given in Section 3, para. 2, subpara. 2 of the StrlSchV, or within the meaning of Sections 47 and 48 of the StrlSchV.

Residual materials whose activities per unit mass or area – after decontamination, where applicable – are so low that they could at most lead to insignificant (trivial) doses in the general population are produced by nuclear facilities, especially during the decommissioning and demolition phases, and in particular from the operation of facilities for the treatment of radioactive substances and spent fuel assemblies. The criterion for triviality for each clearance option is defined in Section 29, para. 1 of the StrlSchV as an effective dose of 10 µSv per year for individual members of the general public, in conformity with the regulations according to Guideline 96/29 Euratom [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 Section 29, para. 2, subparas. 1 and 2 of the StrlSchV, in conjunction with the requirements outlined in Appendix IV of the StrlSchV. Important clearance options include the unrestricted clearance of all types of solid or liquid material, clearance for disposal (on a conventional landfill site or in a thermal waste-treatment plant), the clearance of rubble or soil for recycling (e.g. in road-building), the clearance of buildings for demolition or subsequent use, etc.

The definition of the clearance levels listed in StrlSchV, Table 1, columns 5 to 10a, related to the unrestricted release of solid materials, the release of solid materials for disposal and the release of scrap metal for recycling is based on the recommendation of the Commission on Radiological Protection on the "Clearance of Materials, Buildings and Land Areas with Slight Radioactivity from Notifiable and Licensable Activities" [SSK 98], adopted at its 151st meeting in February 1998. It was shown within the framework of the study [DEC 00] that these values for the unrestricted release as well as for the release for disposal can also be applied to liquids.

For the unrestricted release of building rubble and excavated earth, where the estimated amount arising exceeds 1000 Mg/a, for the unrestricted release of buildings for further use or for re-use, and for the release of buildings for demolition, the clearance levels are based on the recommendations of the European Commission: Radiation Protection 113; Recommended Radiation Protection Criteria for the Clearance of Buildings and Building Rubble from the Dismantling of Nuclear Facilities – Luxembourg 2000 [EC 00], with a deviating rounding procedure applied in the StrlSchV.

The values for the unrestricted release of land areas were developed as part of the BMU-sponsored project "Decommissioning of nuclear facilities – Clearance of Land Areas of Nuclear Sites" [THI 99].

Operators also have the option of submitting so-called “individual proof” (*Einzelnachweis*) of adherence to the effective dose of 10 µSv/a for individual members of the general public. In such cases, the dose is determined on the basis of the specific peripheral conditions at the intended site of use, recycling or disposal.

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

Additionally, in future, due to the EURATOM Basic Safety Standards [1F-18], annual checks are to be conducted to ensure that a collective dose of 1 manSv for the population of Germany is not exceeded by the total clearances in any given year. This collective dose has not been introduced into the Radiation Protection Ordinance as a limit, and the respective competent authority cannot check whether it is adhered to for each individual ruling. However, it is necessary to determine a suitable procedure by which the collective dose can be estimated by the Federal government on the basis of the documents available at the competent agencies. It is envisaged that the estimated collective dose value will then be published by the Federal Ministry of the Environment in its annual reports on environmental radioactivity and exposure.

*Article 24*

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.*

According to Section 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 Section 6 of the "Nuclear Safety Officer and Reporting Ordinance – AtSMV" [1A-17], such an event must be notified immediately to the supervisory authority under the Atomic Energy Act and, if necessary, to the authority responsible for public safety and order, as well as to the authorities responsible for disaster control.

The function of the Incident Registration Centre at the Federal Office for Radiation Protection (BfS) is to record and document all events that occur in nuclear facilities, which are reported by the competent supervisory authorities, and evaluate theses for the BMU. This way, the BfS supports the BMU in its task 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. Irrespective of the reporting process according to AtSMV, events that must be reported are classified by the nuclear facility operators according to the International Nuclear Event Scale (INES) of the IAEA.

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

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

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

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

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

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

According to Section 48 of the Radiation Protection Ordinance, 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 because small radioactive inventory and the kind of work to be carried out within the facility that the limits to be kept will be safely adhered to. This applies in particular to nuclear facilities licensed under Section 7 of the Radiation Protection Ordinance, such as some of the conditioning facilities and interim storage facilities for radioactive wastes in which nor repairs are carried out. Other than nuclear power plants, these facilities release only little or – in individual cases - no radioactivity.

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

It should be noted that the Pilot Conditioning Facility PKA, in which the spent fuel assemblies are dismantled and conditioned ready for emplacement, will only be used for the time being to repair damaged fuel-assembly casks until a suitable repository is complete. There is no need to consider radiation exposure here at present.

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

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

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

**Repository Site for Radioactive Wastes (Morsleben)**
The principal considerations for emissions monitoring are substances such as Rn-222 and its decay products tritium and carbon-14, radioisotopes of thorium, uranium, and the transuranium isotopes, and fission and activation products (cf. Table F-2). Specifically, the discharges in the exhaust air/waste 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-2: Release of radioactive materials with exhaust air and waste water from the Morsleben repository in 2003

| | **Exhaust air/Bq** | **Waste water/Bq** |
|---|---|---|
| Tritium | $2.4\ 10^{10}$ | $6.3\ 10^{4}$ |
| Carbon-14 | $8.2\ 10^{8}$ | - |
| Long-lived aerosols | $1.5\ 10^{6}$ | - |
| Radon decay products | $8.7\ 10^{9}$ | - |
| Nuclide mix except tritium | - | $1.2\ 10^{2}$ |

- 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* (Federal States) are specified under Sections 2 to 5 of this Act, together with the corresponding information system. The Implementing Regulation [2-4] for Section 10 of the Precautionary Radiation Protection Act governs the acquisition and transmission of data. The two parts of the “Guideline on the Monitoring of Environmental Radioactivity in accordance with the Precautionary Radiation Protection Act” (*Richtlinie für die Überwachung der Radioaktivität in der Umwelt nach dem Strahlenschutzvorsorgegesetz*) [3-69] and [3-69-2], which were adopted by a committee of government agencies responsible for administering the Atomic Energy Act, regulate its precise implementation; they distinguish between a routine measurement schedule during normal operation, and an intensive measurement schedule in the event of an incident.

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

- *Deutscher Wetterdienst* (German National Meteorological Service),
- *Bundesanstalt für Gewässerkunde* (Federal Institute for Hydrology),
- *Bundesamt für Seeschifffahrt und Hydrographie* (Federal Board of Shipping and Hydrography),
- *Bundesanstalt für Milchforschung* (Federal Dairy Research Centre),

- *Bundesforschungsanstalt für Fischerei* (Federal Research Centre for Fisheries), and
- *Bundesamt für Strahlenschutz* (Federal Office for Radiation Protection)

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

The IMIS comprises more than 2000 stationary measurement stations for monitoring the local gamma dose rate and 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 during routine operation. 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 Environment Ministry evaluates the data. If threshold values are exceeded, the Ministry can issue an alarm; the governments of the *Länder* (Federal States) are alerted parallel to this by the IMIS.

## Article 25 (Emergency preparedness)

*Article 25*

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.*

### General Aspects

In Germany, a concept of nuclear emergency preparedness has been established which is naturally geared primarily around nuclear power plants. In principle, these rules are applicable to any nuclear facility; however, the effort required may be reduced for the nuclear facilities under consideration here, because their hazard potential is substantially lower in some cases. Within the German federal government, the BMU is responsible for the provision of general criteria for the preparation of emergency plans for the surroundings of nuclear facilities. These are based on the general recommendations for civil protection.

The overall organization of emergency preparedness is governed by co-operation between the Federal Government and the governments of the *Länder* (Federal States), regional government agencies, the police, *Technisches Hilfswerk* (the governmental disaster relief organization), 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.

The task of the Federal government and its competent ministries is to harmonise and, if necessary, co-ordinate the disaster-control efforts between *Länder*, and to initiate protective measures for the population as part of radiation-protection preparedness, such as measures regulating the consumption of foods or spending time out of doors.

Under Section 53 of the Radiation Protection Ordinance [1A-8], no special emergency preparedness measures are required for a nuclear facility if the activity of the radioactive substances handled there does not exceed certain limits. These limits are:

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

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

**Responsibilities of the governments of the *Länder* (Federal States)**

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

In the individual *Länder*, either a medium-level or a lower-level agency is responsible for disaster control. In accordance with the State Disaster Control Act (*Katastrophenschutzgesetz*) of that particular *Land*, alarm and action plans must be drafted and updated by the agency responsible to serve as off-site emergency plans for those nuclear facilities within its jurisdiction for which a safety report is required according to Article 9 of EU Directive 96/82/EC on the Control of Major-Accident Hazards Involving Dangerous Substances (*Official Journal of the EC*, 1997, No. L10, p. 13). 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.

Upon drawing up external 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 external emergency plans assign the competences and responsibilities for management on location, for crisis team management, for the alerting criteria as well as for the stipulation of the necessary civil-protection measures.

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.

The central interim storage facilities for spent fuel assemblies in Ahaus and Gorleben, the North Interim Storage Facility (*Zwischenlager Nord*), and the interim storage facility in Jülich are not subject to any special nuclear emergency preparedness planning, despite the fact that their radioactivity inventories exceed the limits given in Section 53 of the Radiation Protection Ordinance. Internal 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 Section 49 StrlSchV. Disaster control falls under the general disaster-control planning of the *Länder* agencies.

For the Interim Storage Facility for Spent Fuel (*ZAB*) in Greifswald (where contrary to the interim storage facilities for spent fuel assemblies in Gorleben and Ahaus the fuel assemblies are kept in wet storage without containers), there exists a “Special Disaster Prevention Calendar” (*Sonderkatastrophenabwehrkalender*), for off-site emergency preparedness planning.

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

For design basis accidents as well as for events with a low probability of occurrence, radiation exposure in the vincinity of the facility has to be considered. Sections 49 and 50 StrlSchV define the limits of radiation exposure following an accident. If the calculated doses lie below these limits, it is assumed that no significant impacts need to be expected for the population in the vicinity of the facility. Effective doses, resulting e. g. from the release of radioactive materials in consequence of an event, which leads to slightly raised leakage rates off casks or containers, will be far below the accident planning levels according to Section 49 StrlSchV. This means that no comprehensive emergency measures, e. g. the preparation of an off-site emergency preparedness plan, are necessary. The decisions are taken by the competent licensing and supervisory authorities for the nuclear facilities in the *Land* concerned.

The Pilot Conditioning Plant for spent fuel assemblies in Gorleben will not require special nuclear emergency preparedness plans if it becomes operational. The cell wing of the facility is in a bunker and safeguarded against external impacts, in particular against an aircraft crash. In the wing housing the container storage area, protection is safeguarded by the design of the type-B 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.

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

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

The on-site emergency preparedness plans are part of the operating manual of the respective nuclear facility and have to be kept up to date. Various different on-site emergency exercises are carried out at regular intervals, with an increasing use of simulations. Depending on the type of exercise, authority representatives are also involved.

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-2). The operators also take part in these exercises. Appendix XIII Part B of the StrlSchV stipulates that the population has to be informed periodically every five years about the emergency preparedness plans.

Figure F-2: Contamination check during a civil protection exercise (Copyright: Kreisfeuerwehr Nürnberger Land; www.kfv-online.de)

**Measures**

In October 1999, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety issued a catalogue of measures entitled “Overview of measures for the mitigation of radiological exposure following incidents or accidents with non-negligible radiological consequences“ [BMU 99] applicable to disaster control measures and to action under the Precautionary Radiation Protection Act (StrVG) [1A-5].

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

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

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

Table F-3: Intervention reference levels for the measures of sheltering, taking iodine tablets, evacuation as well as temporary and long-term resettlement from [SSK 99]. The application of the intervention reference level of 50 mSv to children and adolescents under the age of 18 corresponds to a later SSK recommendation of 2001 [SSK 01].

| Measure | Intervention reference levels | | |
|---|---|---|---|
| | Organ dose (thyroid) | Effective dose | Integration and exposure paths |
| Sheltering | | **10 mSv** | External exposure over 7 days and effective consequential dose due to radionuclides inhaled during this period |
| Taking iodine tablets | **50 mSv**<br>Children and adolescents up to the age of 18 as well as pregnant women<br>**250 mSv**<br>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 |
| Long-term resettlement | | **100 mSv** | External exposure over 1 year due to deposited radionuclides |
| Temporary resettlement | | **50 mSv** | External exposure over 1 month |

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).

For nuclear power plants, the measurable amounts of activity for iodine, aerosols and noble gases which in case of a release may lead to such radiation exposure of reference individuals of the population in the vicinity of the plant are specified in the alarm criteria for nuclear facilities [SSK 04c] and are converted according to the deviating nuclide vectors for application to the above nuclear waste management facilities.

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

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

- according to the "Basic Recommendations for Disaster Response", the central zone should not exceed a radius of 2 km around the plant. This, however, depends on the local conditions;
- adjacent to this central zone there is the intermediate zone with a radius of 10 km around the plant and
- the outer zone with a radius of 25 km.

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

In accordance with the provisions of EU Directive 89/618 EURATOM [1F-29], section 51, para. 2 of the Radiation Protection Ordinance 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.

**Responsibilities of an Operator of Nuclear Facilities**

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

Operators are obliged to undertake their own precautionary and protective measures, known as “on-site emergency planning” for conceivable nuclear accidents, in advance. These must be detailed in the alarm code and in the emergency manual. 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.

In accordance with Section 53 of the StrlSchV, the operator must have trained personnel and any tools which may be required on hand for controlling safety-relevant events, and must provide the authorities responsible for emergency preparedness mentioned above with the information necessary to deal with an incident. It must assist the competent authorities in planning emergency measures, and inform them of possible risks when deploying helpers, and of essential protective measures.

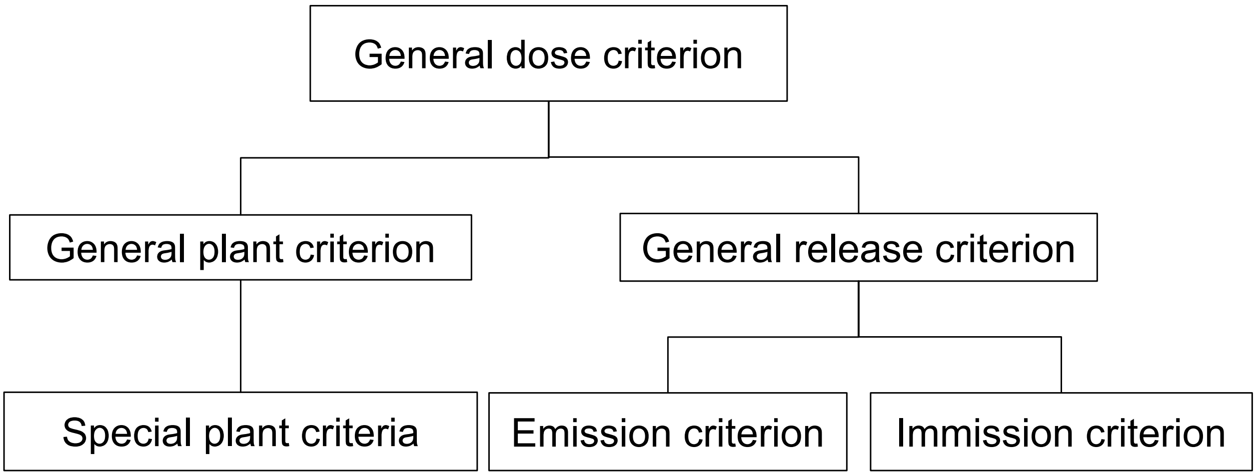
Specifically for the case of fire-fighting, the operator must agree necessary measures in advance in co-operation with the competent *Länder* authorities, the fire service, or the mine rescue service (in the case of repositories). In this respect, it is particularly important to clarify the special equipment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

**Raising the Alarm**

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

In this context, the respective criteria for early warning and emergency alert express whether there are merely concerns that "hazardous" dose levels may be reached (early warning) or whether they are imminent or have already been confirmed (emergency alert). A hazard to the population is assumed if 10 mSv effective dose or 50 mSv thyroid dose are expected for children and adolescents under the age of 18. If the plant state and the release values confirmed by measurements result in 1/10 of this exposure level or raise concerns that such a level may be reached, an early warning has to be issued. An emergency alert has to be raised if full exposure occurs or is threatening to occur. Figure F-3 lists the assessment criteria for triggering the different alarms by the plant operator, with only one criterion already being sufficient for raising an alarm.

Figure F-3: General dose criterion




If a radioactive release from abroad reaches German territory, alerting of the *Länder* is ensured on the one hand by the Federal Government which is informed on the basis of bilateral and international agreements if an event occurs, and on the other hand in parallel by the Integrated Measuring and Information System (IMIS-IT System). The IMIS-IT System, which ensures monitoring measurements across the entire territory of the Federal Republic of Germany, will already trigger an early warning at its Freiburg headquarters and the BMU if the pre-set threshold levels at one of its around 2000 measuring stations for the determination of the local $\gamma$ dose rate are exceeded. These thresholds are specified individually for each measuring station and lie at levels at which the values usually measured during the course of one year would be exceeded. Permanent on-call duty teams evaluate these data within an hour, also considering information provided from other measuring stations; if need be, they transmit the data to the corresponding federal and regional civil protection authorities and increase the measuring frequency of the IMIS-IT System (cf. the remarks on Article 24).

*Article 25*

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.*

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

Germany, international regulations were considered from the start when the limits in the StrlSchV were defined.

The precautions in case of accidents in waste-disposal facilities on neighbouring foreign territory correspond to those applicable to other nuclear facilities, such as nuclear power plants remote from the frontiers. In order to determine the measures necessary under the Precautionary Radiation Protection Act [1A-5], a list of measures [BMU 99] 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.

## Article 26 (Decommissioning)

*Article 26*

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

### Introduction

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

### Legal Basis

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

The licensing procedure for the decommissioning of nuclear facilities is governed by the Ordinance Relating to the Procedure for the Licensing of Facilities in Accordance with Section 7 of the Atomic Energy Act (*Atomrechtliche Verfahrensverordnung,* AtVfV) [1A-10]. It contains regulations pertaining to decommissioning, particularly with regard to third party involvement and environmental impact assessment (EIA).

The pre-requisites which have to be fulfilled for issuing a decommissioning licence are listed in Section 7 para. 2 AtG. As stipulated in Section 7 para. 3, they "accordingly" pertain to decommissioning as for erection and operation of such a plant. The legislator has put the issuance of a licence according to Section 7 paras. 1 and 3 AtG under the reserve of Section 7 para. 2 ("A licence may only be granted if" the pre-requisites of Section 7 para. 2 have been fulfilled). This emphasizes the particular weight that is given to erection and operation as well as to decommissioning, safe enclosure and dismantling of a nuclear installation by the legislator. Other licences regulated by the Atomic Energy Act (e. g. Sections 5 and 6 AtG) or by the Radiation Protection Ordinance (Sections 7 and 9 StrlSchV) 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 Section 7 para. 3 AtG.

If storage has been covered by a separate licence according to Sections 6 or handling according to Section 9 AtG or Section 7 StrlSchV, a separate licence is also required for the termination of the practice and the dismantling of equipment.

Apart from the AtG, the Radiation Protection Ordinance (StrlSchV) [1A-8] 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 organization of radiation protection, for protection of individuals in radiation protection areas, including physical supervision of radiation protection, for the protection of the general public and the environment, for the protection against significant safety-related events as well as for radioactive wastes.

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

**Hazard Potential of Nuclear Installations during the Decommissioning Phase**

The decommissioning of a nuclear installation is characterised by a continuous decrease in the plant's radionuclide inventory, mainly by means of removal of the fuel assemblies and the high-active operational waste, by decontamination and the dismantling of contaminated and activated material, as well as by the final removal of any residual radionuclides above clearance levels and the release from nuclear regulatory control. Generally speaking, this coincides with a continuous decrease in the hazard potential as dismantling progresses. Allowance is made for this fact by including specific decommissioning regulations and recommendations in the sub-statutory regulatory framework, as well as by application of the existing regulatory framework or by revoking supervisory regulations and requirements during the licensing and supervision procedure in line with the decreasing hazard potential.

**Measures to Ensure Safety during Decommissioning of Nuclear Installations**

The information contained in this report with respect to

- Article 18 (Implementing measures),
- Article 19 (Legislative and regulatory framework),
- Article 20 (Regulatory body),
- Article 21 (Responsibility of the licence holder),
- Article 22 (Human and financial resources),
- Article 23 (Quality assurance),
- Article 24 (Operational radiation protection) and
- Article 25 (Emergency preparedness)

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

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

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

- to compile the aspects of licensing and supervision which are relevant in decommissioning procedures,
- to develop a common understanding between the Federal Government and the Federal States how to carry out decommissioning procedures,
- to harmonize 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 Section 7 AtG with respect to the application of the sub-legal regulatory framework, the planning and preparation of decommissioning measures as wells as licensing and supervision. At present, the Guide is under revision and is adapted to the changes in the regulatory framework which have occurred since 1996.

*Article 26*

*Such steps shall ensure that:*

*Article 26*

*i) qualified staff and adequate financial resources are available;*

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

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

- The decommissioning of publicly-owned facilities is financed from the current budget. For most projects (Table F-4), the Federal Government covers the bulk of the costs. Financing includes all expenses incurred for the post-operational and transition phase, disposal of the fuel assemblies, execution of the licensing procedure, dismantling of the radioactive part of the facility, and disposal of the radioactive wastes, including all preparatory steps.

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

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

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

Table F-4: Research facilities in which nuclear installations are operated or decommissioned and which are financed from public funds

| Research facilities | Short description | Normal funding |
|---|---|---|
| Research Centre Karlsruhe (FZK) | Founded in 1956 as “Kernforschungszentrum Karlsruhe”; initial research topics: development of heavy and light water reactors. Current research in numerous fields outside nuclear technology.<br>The “Nuclear Facilities Decommissioning” department carries out the decommissioning and dismantling of research reactors (FR-2, MZFR, KNK II) as well as the Karlsruhe Reprocessing Plant (WAK), erection and operation of the vitrification plant VEK together with WAK | Federal Republic of Germany, *Land* Baden-Württemberg |
| 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.<br>Operation of research reactor FRJ-2; decommissioning of research reactor FRJ-1 | Federal Republic of Germany, *Land* North Rhine-Westphalia |
| 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.<br>Operation of the research reactor FRG-1, decommissioning of the research reactor FRG-2, execution of the storage and disposal of radioactive wastes from the nuclear ship Otto Hahn | Federal Republic of Germany, *Länder* Schleswig-Holstein, Lower Saxony, Hamburg, Bremen |
| National Research Centre for Environment and Health (GSF), Munich | Founded in 1964 as “*Gesellschaft für Strahlenforschung*” (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. | Federal Republic of Germany, Free State of Bavaria |
| Hahn Meitner Institute Berlin (HMI) | Founded in 1959; current research topics in the areas structural research, material sciences etc.; operation of the research reactor BER II | Federal Republic of Germany, *Land* Berlin |
| VKTA / Nuclear Engineering and Analytics Rossendorf Inc. (*Verein für Kernverfahrenstechnik und Analytik e.V.),* Rossendorf | Founded in 1957 as the “*Zentralinstitut für Kernforschung*” (Central Institute for Nuclear Research) of the former GDR; was restructured into the Research Centre Rossendorf and the *Verein für Kernverfahrenstechnik und Analytik (VKTA) e. V.* Rossendorf following reunification.<br>VKTA carries out the decommissioning of the research reactor RFR and of the AMOR facilities; the zero-power research reactors RRR and RAKE have already been fully dismantled and removed. | VKTA: Free State of Saxony |
| Various universities | Operation / decommissioning of smaller research reactors | Federal Republic of Germany, respective *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. This will continue to apply in the light of the planned phase-out of nuclear power (cf. the remarks on Article 22 (i)).

*Article 26*

*(ii) the provisions of Article 24 with respect to operational radiation protection, discharges and unplanned and uncontrolled releases are applied;*

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. Section 47, para. 1 of the Radiation Protection Ordinance (StrlSchV) prescribes limits governing the maximum doses per calendar year caused by the release of radioactive substances with air or water from these facilities or installations applicable to individual members of the general public. According to Section 47, para. 1 of the StrlSchV, provisions must be taken in order to prevent the uncontrolled discharge of radioactive substances. According to Section 47, para. 3 of the 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 Section 48 of the StrlSchV.

*Article 26*

*(iii) the provisions of Article 25 with respect to emergency preparedness are applied;*

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).

*Article 26*

*(iv) records of information important to decommissioning are kept.*

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

**Keeping of Records of Information Pertaining to Construction and Operation**

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

> "The documentation arising during the construction and operation of nuclear power plants comprises all technical documents and other data carriers which will serve as proof in the licensing and supervisory procedure. As a general principle, the documents needed to assess the quality of design, manufacture, construction and testing as well as of the operation and maintenance of safety-relevant plant parts must be kept available throughout the plant's entire lifetime.
>
> The purposes and functions of documentation are to
>
> a) indicate the existence of or compliance with statutory prerequisites (e.g. licensing prerequisites in accordance with Section 7, para. 2 of the Atomic Energy Act (AtG))
>
> b) describe the desired state of the plant and essential processes during its construction,
>
> c) permit an assessment of the actual state of the plant,
>
> d) represent the facts required for the safe operation of the plant,
>
> e) permit feedback of experience."

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

> "The documents compiled shall be complete with respect to the safety-related information contained therein and shall describe both the desired values and the actual state of the plant and its parts.
>
> The applicant or licensee shall be responsible for the preparation, maintenance and updating of the documentation."

This means that not only the state of the plant at the start of operation must be fully documented but that this documentation must also be adapted to all changes and must reflect the actual state of the plant at all times. This ensures that all relevant information from the operating phase is available when required for the decommissioning phase. KTA 1404 further specifies that the documentation must be safely kept at a place and in a form suitable for long-term storage, and that a secondary set of documents must be retained at a place where it is not endangered by any impact that may originate from the plant. The period for which records have to be kept depends on the type of documents and ranges from 1 to 30 years.

These requirements also apply analogously to other types of nuclear installations in the scope of this Convention. Within the context of nuclear regulatory supervision, the competent authority satisfies itself that the records have been duly updated and correctly filed.

**<u>Keeping of Records of Information from the Decommissioning Phase</u>**

As for the operating phase, information from the decommissioning phase which have to be kept for longer periods of time cover a number of topics, such as operation, surveillance and radiation protection, in particular:

- protocols from the shifts,
- protocols of surveillance and measurements of activity releases,
- reports on accidents and incidents as well as the chosen countermeasures,
- record keeping of measurements of individual doses and body doses,

- record keeping on extraction, production, acquisition, transfer and other dispositions of radioactive substances,
- protocols of contamination measurements according to Section 44 StrlSchV in cases where limits were exceeded.

Record keeping on extraction, production, acquisition, transfer and other dispositions of radioactive substances which is regulated in Section 70 StrlSchV is of particular relevance for the decommissioning phase. Section 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.

Section 70, para. 6 of the 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.

## Section G. Safety of Spent Fuel Management

### Article 4 (General safety requirements)

*Article 4*

*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.*

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 prevented, and, with due regard for the state of the art in science and technology and the particular circumstances of each individual case, is kept as low as practicable even where the values are below the authorized limits (Section 6 StrlSchV).

The planning of structural or technical measures to protect against design-basis accidents is based on the dose limits for the environment (Sections 49 and 50 StrlSchV) or is applied *mutatis mutandis*.

The following principles for spent fuel management are derived from the precautionary concept:

- fundamental protection targets on radioactivity confinement, removal of decay heat, subcriticality, avoidance of unnecessary radiation exposure,
- requirements regarding shielding, design and quality assurance, safe operation 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 and operation of nuclear installations is subject to regulatory licensing. The licensing of nuclear installations is regulated by the Atomic Energy Act (cf. the remarks on Article 19).

Additional requirements regulate liability in case of damages [1A-11], protection against disruptive actions or other interference by third parties [3-62], [BMU 00] and the control of fissile material according to international conventions (cf. the remarks on Article 24).

*Article 4*

*In so doing, each Contracting Party shall take the appropriate steps to:*

*Article 4*

*(i) ensure that criticality and removal of residual heat generated during spent fuel management are adequately addressed;*

Measures are taken to address the derived fundamental protection targets of reliable compliance with subcriticality and safe removal of residual heat. Particularly regarding the dry interim storage of spent fuel assemblies from LWR, HTR, prototype and research reactors, these measures are specified in greater detail by the RSK Guideline on safety technology [4-2]. With regard to criticality safety in connection with the wet interim storage of spent fuel assemblies, KTA 3602 is applied (see enclosed list of KTA nuclear safety standards), whilst KTA 3303 is applied with regard to the removal of residual heat.

At present, the nuclear regulations do not yet contain any formulated requirements as to how criticality is to be avoided in a repository and how residual heat is to be removed in a suitable manner. Within the framework of the plan approval procedure for the Konrad repository, however, measures have been taken to ensure that any criticality is avoided and that allowance is made for residual-heat removal. The basic criteria applied in this plan approval procedure will also have to be applied in future procedures.

According to the safety criteria for the emplacement of radioactive wastes in a mine, the thermal output and surface temperature of the packages for the disposal of radioactive wastes should be determined in such a way that the specified properties of the packages are maintained and the integrity of the geological formation is not endangered.

*Article 4*

*(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;*

Section 6, paragraphs 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 authorized limits. Based on this, and analogous to Section 22 of the Closed Substance Cycle and Waste Management Act [1B-13], we derive the requirement to keep the generation of radioactive waste associated with spent fuel management to the minimum practicable. Measures to reduce the amount of spent fuel assemblies arising are the increase of target burnup and fuel assembly enrichment as well as the optimisation of fuel burnup by fuel assembly shuffling. The abandonment of spent fuel assembly reprocessing avoids the generation of additional volumes of radioactive waste.

In addition, according to the Guideline on the Control of Radioactive Waste with Negligible Heat Generation that is Not Delivered to a State Collecting Facility [3-59], waste originators are required to submit a waste concept containing information about the avoidance or reduction of radioactive waste generation to the competent authority of the *Länder* (Federal States).

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 waste arising.

*Article 4*

*(iii) take into account interdependencies among the different steps in spent fuel management;*

Following the most recent revision of the Atomic Energy Act (AtG), according to Section 9a of the AtG it is necessary to prove to the supervising authority that adequate provisions exist for the non-hazardous re-use or controlled disposal of spent fuel assemblies (*Entsorgungsvorsorgenachweis*). For this purpose, realistic plans are submitted annually showing that sufficient interim storage capacity remains available for those spent fuel assemblies already existing and those expected to arise in future, and that sufficient and adequate interim storage facilities are legally and technically available to meet concrete requirements for the next two years. Furthermore, similarly structured proof is also furnished to the supervising authorities regarding the interim storage of returned wastes from the reprocessing of spent fuel assemblies in foreign countries, as well as for the re-use of the separated plutonium from the reprocessing of spent fuel assemblies in nuclear power plants, and for the whereabouts of the separated uranium from the reprocessing of spent fuel assemblies.

The type of conditioning and packaging depends on the specifications of the acceptance criteria laid down in the licence for the planned interim storage facility or repository.

Quantitative information showing the consideration of the interdependencies can be found in the comments on Article 32 2.

*Article 4*

*(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;*

The Atomic Energy Act and the Radiation Protection Ordinance require that precautions must be taken against potential damages in keeping with the state of the art in science and technology to guarantee effective protection. For compliance with the state of the art in science and technology on spent fuel management, internationally accepted criteria and standards of the IAEA [IAEA 94b] [IAEA 02], the ICRP and the EURATOM Basic Safety Standards [1F-18] are also referred to. This is ensured by the nuclear licensing applicable to all nuclear installations (cf. the remarks on Article 19).

Compliance with the provisions of nuclear licensing is ensured by the supervision of the competent authorities of the Federal Government and the *Länder* (cf. the remarks on Article 32 2).

*Article 4*

*(v) take into account the biological, chemical and other hazards that may be associated with spent fuel management;*

The precautions against damage from biological, chemical and other hazards make allowance for the provisions of other legal fields (cf. the remarks on Article 19). This primarily concerns the reprocessing and disposal of spent fuel assemblies. There is no reprocessing plant 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 containers ensure leak-proof confinement, which precludes such hazards.

In addition, the Nuclear Licensing Procedures Ordinance stipulates the performance of an environmental impact assessment and compliance with other licensing requirements (e.g. for non-radioactive emissions and discharges into waters).

*Article 4*

*(vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;*

There are no plans for the long-term interim storage of spent fuel assemblies in Germany. Interim storage is limited to a maximum of 40 years. The valid safety criteria [4-2] require that the permitted impacts of interim storage remain at a consistently low level throughout the entire period.

Safety criteria for the emplacement of radioactive wastes in a mine entered into force in Germany in 1983 [3-13]. They are being further developed with due regard for national and international developments, and consider the recommendations of the ICRP and OECD/NEA, the standards of the European Communities, and the safety principles of the IAEA on radioactive waste management [IAEA 95]. In particular, they fully consider Principle 4 of the IAEA Safety Fundamentals not to expose future generations to radiological impacts in excess of those accepted today.

Accordingly, 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 [3-13] that still apply implicitly specify a dose limit of 0.3 mSv per calendar year.

*Article 4*

*(vii) aim to avoid imposing undue burdens on future generations.*

The controlled phasing-out of the use of nuclear energy for the commercial generation of electricity is regulated by the amended Atomic Energy Act which entered into force on 27 April 2002. This also limits the generation of further nuclear waste and minimises the risk of resultant possible burdens on future generations.

The safety criteria for disposal [3-13] in Germany already make allowance for Principle 5 of the IAEA Safety Fundamentals [IAEA 95]. They ensure that no undue burdens are imposed on future generations. In this respect, financial resources have been set aside by the operators of the nuclear power plants for the direct disposal of spent fuel assemblies on the basis of the Ordinance on Advance Payments (EndlagerVlV) [1A-13].

Around 45 % of these reserves are intended for decommissioning and removal, whilst the remaining 55 % are intended for disposal. If required, the reserves will also cover the interim storage of spent fuel assemblies and radioactive waste in Germany until their final disposal.

Once a repository has been sealed, permanent monitoring is not necessary. For this reason, no further costs are incurred after sealing that would have to be borne by future generations.

Development of a concept for the direct disposal of spent fuel assemblies has reached technical maturity. There exists a prototype of a fully shielded POLLUX container as well as the alternative concept of the unshielded fuel rod canister.

## Article 5 (Existing facilities)

*Article 5*

*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.*

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 substatutory regulations (cf. the remarks on Articles 18 to 20) which satisfy, and in some cases exceed, all the requirements of this Convention. An explicit review 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 Section 17 of the AtG.

Independently from this, the regulatory framework governing the safe management of spent fuel [4-2] stipulates regular reviews intended to ensure the continued compliance with the protection targets stipulated in the Act in line with the latest state of the art in science and technology. The protection targets 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.

## Article 6 (Siting of proposed facilities)

*Article 6*

1. *Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed spent fuel management facility:*

*Article 6 1.*

(i) *to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime;*

Section 7, para. 1 of the Atomic Energy Act (AtG) [1A-3] regulates the licensing of stationary installations for the management of spent fuel assemblies, whilst the licensing of the mere storage of nuclear fuel outside Government custody is regulated in Section 6, para. 1 of the AtG. The definition of the AtG encompasses storage of spent fuel assemblies. In order to obtain such a licence, the applicant must submit documentation containing all the relevant data required for the purposes of assessment. This data is summarised in the safety report (*Sicherheitsbericht*), a key document in the licensing procedure. The nature and scope of documentation and the data it contains are regulated in the Nuclear Licensing Procedures Ordinance (AtVfV) [1A-10].

Section 2 of the AtVfV prescribes that the licence application for the planned construction of a new facility must be submitted in writing to the licensing authority. This application must also contain data pertaining to all relevant site-related factors.

Section 3 of the 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. The relevant sections of a safety report generally refer to the following site-specific data: geographic location, human settlements, land use within a 10 km radius, traffic, meteorological conditions, geological conditions, hydrological conditions, seismic conditions, radiological exposure at the site due to pre-radiation, auxiliary and emergency installations in the vicinity of the site.

An Environmental Impact Assessment (EIA) is required for installations which are listed in Appendix 1 of the Environmental Impact Assessment Act (UVPG) [1B-14]. According to nos. 11.1 and 11.3 of Appendix 1 of the UVPG, an environmental impact assessment is required for the construction and operation of facilities for the treatment of spent fuel assemblies, as follows:

11.1 Construction and operation of a stationary installation for the production, treatment, processing or fission of nuclear fuel or the reprocessing of irradiated nuclear fuel

11.3 Construction and operation of a facility or installation for the treatment or processing of irradiated nuclear fuel or highly radioactive waste or for the sole purpose of storage of irradiated fuel or radioactive waste which is scheduled to last for more than 10 years at a place different from the one where these materials have arisen.

The licence application must be accompanied by further documents as specified in Section 3, para. 2 of the Nuclear Licensing Procedures Ordinance (AtVfV) (cf. the section on EIA under the remarks on Article 19 2. (ii)):

1. an overview of the most relevant alternatives for the technical procedures, including reasons for the choice, as far as these information may be relevant for the assessment of the admissibility of the intended work according to section 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 authorized 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.

*Article 6 1.*

*(ii) to evaluate the likely safety impact of such a facility on 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, exposure as a consequence of incidents
- Incident (design basis accident) analysis: Description of the protection objectives, possible incidents, incident analysis for operation, exposure as a result of incidents
- 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 authorized experts consulted by them to assess the presumed effects of a spent fuel management facility on the safety of individuals, society and the environment.

*Article 6 1.*

*(iii) to make information on the safety of such a facility available to members of the public;*

Projects to construct a spent fuel management facility are publicly announced and the documents are publicly displayed in accordance with the provisions of Section 4 of the Nuclear Licensing Procedures Ordinance (AtVfV). The public hearing which may be necessary is regulated in Sections 8 to 13 of the 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 Section 7 of the AtVfV with the opportunity to explain their objections. According to Section 12 para. 1 of the AtVfV, the public hearing is not open to the general public.

Details concerning the related procedures are described in the section on involvement of the public under the remarks on Article 19 2. (ii).

This approach, particularly the involvement of the public as defined in the AtVfV and the Environmental Impact Assessment Act (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.

*Article 6 1.*

*(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.*

Section 7a of the AtVfV regulates the procedure for cases of transboundary environmental impacts; this procedure is also relevant to spent fuel management facilities. According to Section 7a, para. 1 of the AtVfV, the competent authorities of the foreign state are notified of the project with respect to EIA at the same time and to the same extent as the authorities which are to be involved under the terms of the German Atomic Energy Act, in cases where

- a project which is subject to EIA may have substantial impacts (as described in the safety report or in the information on other environmental impacts) on the protected entities cited in Section 1a of the AtVfV (man, animals, plants, soil, water, climate, landscape, cultural or other material assets) in a foreign state, or
- a foreign state which may be substantially affected by such impacts requests this information.

An appropriate period is set for the competent authorities of the foreign state to indicate whether they would like to be involved in the process.

The licensing authority in Germany should ensure that the project is publicly announced in a suitable way in the foreign state, that details are given of the authority to whom any objections may be submitted, and that mention is made of the fact that any objections not founded on titles under private law are excluded once the set period for objections has expired.

On the basis of Sections 2 and 3 of the AtVfV, the German licensing authority will give the involved authorities of the foreign state the opportunity to voice their opinions on the application on the basis of the submitted documents within an appropriate period before reaching its decision. Citizens of that state are accorded equal status with German citizens with respect to their further involvement in the licensing procedure.

Section 7a, para. 2 of the AtVfV specifies that upon request, the applicant must supply translations of the required summary, as well as any other information about the project which may concern transboundary involvement, in particular concerning transboundary environmental impacts.

According to Section 7a, para. 3 of the AtVfV, consultations are to be held, where necessary, between the supreme German Federal and the authorities of the *Länder* (Federal States) and the competent authorities of the foreign state regarding the transboundary environmental impacts of the project and any measures for avoiding or ameliorating them.

Furthermore, Section 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.

*Article 6*

*2. In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 4.*

The effects of the operation of spent fuel management facilities on protected commodities, such as man, animals, plants, soil, water, air, etc., are described in the documents supplied by the applicant, as outlined in the remarks on Article 6 1.

Effects on other Contracting Parties of this Convention which are adjacent to the spent fuel management facility may result from the licensed liquid and gaseous releases from the plant during normal operation and from possible additional releases to the environment during incidents:

- The release of radioactivity during normal operation is limited by Section 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 Sections 49 and 50 of the StrlSchV, respectively, depending on the type of facility. Section 49 of the StrlSchV specifies that for local interim storage facilities for spent fuel assemblies, the doses caused by releases of radioactive substances into the environment in the case of the most severe design basis accident must not exceed the limits specified in Table F-1. In cases falling under the scope of Section 50 of the StrlSchV, the nature and extent of protective measures are stipulated by the competent authority, with due consideration for the individual case, particularly with regard to the hazard potential of the plant and the likelihood of an incident occurring.

Concerning the effects on other Contracting Parties, it is important to consider that the AtVfV prescribes the involvement of the authorities of affected neighbouring states (see above). As such, those authorities will be informed about the possible radiological effects of normal operation of the plant as well as any potential incidents. Provided the specified dose limits, which correspond to the relevant EU regulations and to international standards, are also used as a basis by other Contracting Parties, then the effects will also be acceptable to them.

**Article 7 (Design and construction of facilities)**

| *Article 7* |
|---|
| *Each Contracting Party shall take the appropriate steps to ensure that:* |

| *Article 7* |
|---|
| *(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;* |

For these facilities (cf. Table L-1 to Table L-4), the protection objectives according to Section 1 no. 2 AtG 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 Section 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, Section 6 para. 2 AtG contains the licensing conditions which – if adhered to – ensure that the protection objectives are fulfilled. Both cover the stipulations of the Joint Convention.

During the licensing procedure, the competent licensing authorities make sure that the corresponding requirements are fulfilled. This means that constant checks are performed during the design phase already that the protection objectives are fulfilled, both under normal operating conditions and in the event of an uncontrolled accidental release.

| *Article 7* |
|---|
| *(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;* |

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 licensed for a specified purpose and the facilities must be removed once the licence has expired. There are also regulations governing decommissioning and dismantling. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) has decreed that the RSK safety guidelines on dry interim storage of irradiated fuel assemblies in containers [4-2] must be observed. A further order from the BMU stipulates that this shall be applied analogously to temporary storage facilities. This guideline contains the following provision concerning decommissioning (section 2.16):

"The interim storage facility for spent fuel assemblies shall be designed and built in such a way that it can be decommissioned in compliance with the radiation protection regulations and can either be made available for alternative use or removed. Prior to any further use or the dismantling of the storage building, it must be demonstrated by measurements that the building is not contaminated or has been sufficiently decontaminated and is free of any inadmissible activation. The requirements under building and waste law shall be observed." This means that the radiation protection principles and requirements set forth in the StrlSchV must be observed during the decommissioning and dismantling of these types of facilities. However, additional regulations from the Closed Substance Cycle and Waste Management Act and the building regulations of the *Länder* (Federal States) 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.

*Article 7*

*(iii) the technologies incorporated in the design and construction of a spent fuel management facility are supported by experience, testing or analysis.*

The construction of installations in Germany is governed by the commonly accepted technical rules – e.g. as laid down in the DIN/EAN standards. In the nuclear sector, the requirements specified in KTA rules additionally apply (cf. the remarks on Article 13 2. (i)) and the state of the art in science and technology must also be observed.

These standards, as well as the state of the art in science and technology, are derived from experience. Hence, in Germany, the experience gleaned from nuclear research installations as well as from industrial application have been incorporated into the regulatory framework. Technical rules are issued by the KTA, which is comprised of representatives from research, industry and administrative bodies who pool their experience from the various different areas of nuclear safety.

The development of transport and storage containers is based on many years of experience in the design and manufacturing of such containers, 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.

## Article 8 (Assessment of safety of facilities)

*Article 8*

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

*Article 8*

*(i) before construction of a spent fuel management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;*

The assessment of the safety of nuclear facilities for the treatment of spent fuel assemblies (central and local interim storage facilities and temporary storage facilities, and the Gorleben pilot conditioning plant PKA), and the assessment of environmental impacts conducted prior to the construction of such a facility, take place within the context of a licensing procedure (cf. remarks on Article 19 2. (ii)).

An assessment of the safety and environmental impacts conducted prior to commissioning takes place within the context of the accompanying supervision under the relevant nuclear laws.

The construction and operation of nuclear facilities for spent fuel management is subject to licensing under the Atomic Energy Act (AtG) [1A-3]. For the building work, a building permit is also required under the Building Code of the respective *Land* (Federal State).

Applications for licences under the Atomic Energy Act must be submitted to the competent licensing authority. The application must include a statement on the extent to which the nuclear facility ensures the necessary precautions against damage resulting from the treatment of spent fuel assemblies according to the state of the art in science and technology, and meets the requirements of the rules and regulations in force. The nature and content of the documents submitted with the application must meet the requirements of the Nuclear Licensing Procedures Ordinance (AtVfV) [1A-10], or in the case of facilities for the storage of spent fuel assemblies, must fulfil them *mutatis mutandis*. The documents required (see also KTA 1404, cf. the list of KTA rules in the Appendix) are listed in detail in the remarks on Article 19 2. (ii) and (iii).

Under Section 12b of the Atomic Energy Act (AtG), the competent authorities carry out checks on the reliability of the persons responsible for the handling of radioactive substances, so as to guard against unauthorized actions which could lead to misappropriation or the substantial release of radioactive substances [1A-19].

In order to implement the corresponding European requirements for an environmental impact assessment under [1F-13], which have been implemented in national law by the revision of the Environmental Impact Assessment Act (UVPG) [1B-14], an environmental impact assessment is conducted as a subsidiary part of the licensing procedure for the construction of nuclear facilities for the storage of spent fuel assemblies for which applications have been submitted since 1999. In such cases, the following documents must be added to the application:

- a presentation of the possible effects of the project on humans, fauna, flora and their habitats, on water, air, and the climate, as well as on the landscape and cultural and material assets,
- an overview of the technical process alternatives examined by the applicant, and the reasons for selection, if significant, as well as
- notes on any difficulties experienced in compiling the information for the assessment of environmental impacts.

According to Section 20 of the AtG, the competent authorities may call upon independent experts in the licensing and supervision procedure. The basic requirements governing expert opinions are formulated in a directive [3-34]. The independent experts review in detail the documents and licensing prerequisites submitted by the applicant. On the basis of the evaluation standards, details of which must be included in the expert opinion, they perform their own tests and calculations – preferably using methods and programs other than those of the applicant – and give an expert assessment of these results. Unless there are specific provisions governing the safety assessment of nuclear facilities for the treatment of spent fuel assemblies, any relevant rules from the existing set of rules and regulations for the safety assessment of nuclear power plants are applied *mutatis mutandis* (e. g. [3-23], [3-33], [3-1] and KTA 2101). Specific requirements for nuclear facilities for the treatment of spent fuel assemblies may be derived from international recommendations, such as those of the IAEA ([IAEA 94] and [IAEA 94a]).

For the technical design and the operation of facilities for the dry interim storage of irradiated fuel assemblies in containers, guidelines apply that were recommended in 2001 [4-2] by the Reactor Safety Commission (*RSK*). These guidelines were prepared in the wake of the large number of license applications in 1999 and 2000 to build and operate on-site interim fuel assembly storage facilities. With the exception of one facility that was licensed in 2004, all the other ones had been granted their licences by the end of 2003.

According to these guidelines, the technical design and operation of an interim storage facility must meet the following radiological protection targets in order to ensure that the precautions against damage reflect the state of the art in science and technology:

- Secure containment of the radioactive inventory
  The barriers or fuel-assembly casks that ensure the containment must retain sufficient integrity (monitoring of sealing function, formulation of a repair concept) under all credible circumstances (hazardous incidents, accidents, ageing, impacts, etc.)
- Avoidance of unnecessary radiation exposure, limitation and monitoring of the radiation exposure of operating personnel and the general population
  Adherence to the corresponding limit values of the Radiation Protection Ordinance (StrlSchV) [1A-8], even in the most unfavourable case (receiving and dispatching checks on the fuel-assembly casks, formulation of a radiation-protection concept, division of the interim storage facility into radiation protection zones, radiation monitoring in the interim storage facility and the vicinity).

- Reliable maintenance of subcriticality
  Proof of the criticality safety of the fuel assemblies during storage shall be demonstrated for the least favourable conditions to be expected during specified normal operation (limitation of the enrichment of the fuel assemblies, exclusion or limitation of neutron moderation, use of neutron absorbers, maintenance of the appropriate spacing) [DIN 25403], [DIN 25474].
- Sufficient removal of heat from radioactive decay
  Even in the case of combined impacts on the effectiveness of heat removal, the operators must guarantee that only admissible temperatures will occur. The mechanisms of heat removal must be independently operative as far as possible (passively by natural convection).

From these protection goals, further requirements can be derived which are essential for compliance with the above targets:

- Shielding of the ionizing radiation,
- Design, execution, and quality assurance suitable for operation and maintenance (KTA 1401, cf. list of KTA rules in the Annex),
- Safety-oriented organization and performance of operation,
- Safe shipment off-site of the radioactive materials (see also [IAEA 96a]),
- Design against accidents, and provision of measures to reduce the harmful effects of events that exceed the design parameters (incident analysis). Calculation of the effects of hazardous incidents and of pre-existing pollution prevailing at the site before the facility is erected is regulated by [2-1] and [3-33].

In addition, external impacts of natural and artificial origin are also to be considered, according to the guidelines (cf. also [BMU 00], [3-62]). These impacts will be assessed in the licensing process by the competent licensing authority. Recommendations for disaster management procedures are given in [3-15] (cf. the remarks on Article 25).

In the context of the incident analysis (extraordinary events), a distinction is made between external and internal events, the latter being caused by the spent fuel assembly treatment facilities themselves.

In connection with dry interim storage, the following internal events generally have to be considered:

- mechanical impacts, such as the crash of a fuel assembly container, a container toppling over upon handling, and the crash of a load onto the container (cf. drop test examples of BAM in Figure G-1 and Figure G-2),
- fire (cf. fire test example of BAM in Figure G-1) 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: First drop test and fire exposure test of a fuel assembly transport container for radioactive waste in original size from a height of 9 m at the test facility of Federal Institute for Materials Research and Testing (BAM) in Berlin in 1978 (copyright: BAM).

Figure G-2: Drop test of a spent fuel assembly transport and storage container at the new Federal Institute for Materials Research and Testing (BAM) test facility in 2004 (copyright: BAM).

External impacts that have to be considered are:

- external natural impacts such as storm, rain, snow, frost, lightning, flooding, landslides and earthquakes,
- external man-made impacts such as the effects of harmful substances (e. g. poisonous or explosive gases), blast waves caused by chemical explosions, fires (e. g. forest fires) spreading to the facility, mines caving in, and aircraft crashes.

Effects from events affecting a neighbouring power plant are also considered, e. g. the collapse of a vent or other structures, a turbine failure, or the failure of vessels with high energy content, as far as debris from such events may affect the interim storage facility.

The aspects of operational lifetime are taken into account by the limitation of the operating licenses for on-site interim storage facilities and the storage time of a container to 40 years as well as by the consideration of this period in the licensing procedure. By imposing further conditions at a later stage the operating 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. Section 17 para. 1 no. 3 AtG).

*Article 8*

*(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).*

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 latter determines whether the statements contained in the documents submitted, and any supplementary requirements in the licence, are being observed and implemented. Independent experts are also consulted for these supervisory duties.

If there are any relevant deviations from the state of the art in science and technology as specified in the licensing documents, modifications become necessary according to Section 7 para. 1 AtG for which a modification licence is required; in this connection, all documents also have to be adapted to the corresponding state of the art in science and technology. Here, it has to be checked whether the modified facility satisfies overall the imperative of damage precaution, with this check extending to all effects of the modification on the safety of the facility and its operation. A deviation from the licensed status or operation of the facility is considered as being substantial if it does not show merely irrelevant consequences for the safety level at the facility. Modification licences are applied for at the competent licensing authority by the operator of the respective nuclear facility, if necessary 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* (Federal State).

Figure G-3: Aerial photo of the Ahaus interim fuel assembly storage facility (copyright: GNS)

According to the Reactor Safety Commission's guidelines [4-2], with regard to the operation of an interim storage facility (cf. Figure G-3 the transport container storage building at Ahaus as an example of an interim fuel assembly storage facility), precautionary measures against damage must be taken in particular for all procedures leading to first-time achievement of the normal operating state of the nuclear facility (commissioning).

The precautionary measures specified therein include:

- commissioning tests of all equipment of the storage facility (commissioning program),
- preparation of instructions for operational procedures and procedures for the management of incidents and eliminating the consequences thereof (operating manual in accordance with KTA 1201; cf. list of KTA rules in the Annex),
- drafting of implementing provisions for adherence to the Technical Acceptance Conditions (*Technische Annahmebedingungen*) (the boundary conditions for vessel properties and fuel assemblies used in the safety studies),
- the keeping of an inspection manual on in-service inspections (inspection manual according to KTA 1202; cf. list of KTA rules in the Annex),
- centralized 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.

**Article 9 (Operation of facilities)**

*Article 9*

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

*Article 9*

*(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;*

In Germany, only interim storage facilities are operated for spent fuel management since the pilot conditioning plant (PKA) has not yet commenced operation and no repository is available yet. Therefore the following will only deal with interim storage facilities.

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 instruction manual for operational processes, accident management and elimination of the consequences of incidents and accidents. Competencies and responsibilities must be clearly defined. The competent authority supervises compliance.

At each facility, cold testing with one cask for each cask type licensed for storage is performed for the entire handling procedure, including radiation protection measures, before casks are stored there for the first time.

*Article 9*

*(ii) operational limits and conditions derived from tests, operational experience and the assessments, as specified in Article 8, are defined and revised as necessary;*

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 instruction 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 as well as the limits specified for temperature and inter-lid pressure in the operating licence are kept. Upon defining these limits, the results of trials, existing operating experience as well as assessments according to Article 8 are taken into account. This affects in particular measures for monitoring the leaktightness of the containers and, if necessary, measures to re-establish the double barrier function. 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 supervisory authority.

*Article 9*

*(iii) operation, maintenance, monitoring, inspection and testing of a spent fuel management facility are conducted in accordance with established procedures;*

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 [4-2] 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 container qualification document by the Federal Institute for Materials Research and Testing (BAM) 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 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 for control purposes, e.g. by means of mobile air sample collectors. Transport areas within the storage area, persons, work places, transport routes and mobile objects are all checked for contamination by suitable means and the results documented. Suitable decontamination facilities must be provided and organisational specifications made.
- In order to ensure the radiological work safety of the operating personnel and the protection of the population, air samples are taken at regular intervals in the storage area near the emplaced casks and subsequently analysed, the local dose (gamma and neutron dose) is monitored at representative points, e. g. at the fence of the facility, and the correct functioning of the equipment provided and used for radiation monitoring is systematically and regularly checked.

- The facility disposes of sufficient numbers of qualified personnel to ensure the fulfilment of safety requirements, who are trained on a regular basis. This may be ensured by deployment of personnel from neighbouring nuclear installations. The technical qualification required depending on the staff member's position is verified in accordance with the requirements of the Radiation Protection Ordinance (StrlSchV) or other special regulations. The requirement concerning responsibility for nuclear safety issues is regulated by the Atomic Energy Act (AtG) [1A-3] and the StrlSchV.
- A monitoring concept is drawn up in order to control long-term and ageing effects during the interim storage facility's operational period as detailed in the licence application. Here, a general distinction is made between parts and components that are designed for the entire period of use of the facility, and those that may need to be replaced.

The essential safety-related properties of the systems, parts and components are ensured for the entire operating period. In particular, the condition of the lifting trunnions must allow the casks to be moved within the facility at any time.

Regulatory supervision ensures compliance with the procedures on operation, maintenance, monitoring, inspection and testing established in the nuclear licensing procedure for spent fuel management facilities.

*Article 9*

*(iv) engineering and technical support in all safety-related fields are available throughout the operating lifetime of a spent fuel management facility;*

We have already reported on the measures to ensure engineering and technical support during the operating lifetime of the facilities by providing adequate competent staff 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 crane 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.

*Article 9*

*(v) incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body;*

The obligation incumbent open operators of facilities licensed according to Section 6 or Section 7 of the Atomic Energy Act (AtG) [1A-3] to report accidents, incidents and other events significant to safety to the supervisory authority is regulated in the Nuclear Safety Officer and Reporting Ordinance (AtSMV) [1A-17].

Operation of the facility is monitored to check that safety-relevant disruptions to operation and incidents are reliably detected and the corrective measures specified in the instruction 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 5 days, depending on the severity of the event. For facilities that are licensed according to Section 7 para. 1 AtG, the reporting procedure and the reporting obligation criteria are laid down in the Nuclear Safety Officer and Reporting Ordinance (AtSMV) [1A-17]. 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 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.

*Article 9*

*(vi) programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;*

In view of the obligation of the authorities to take precautionary action, incidents significant to safety must be reported in accordance with the Nuclear Safety Officer and Reporting Ordinance (AtSMV). Such incidents are recorded and evaluated at the incident registration centre of the Federal Office for Radiation Protection.

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:

- Reports on the condition of the storage building and the components required for interim storage are regularly prepared by the operator at intervals of ten years.
- 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.
- Random inspections are performed on the storage casks.
- 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.

*Article 9*

*(vii) decommissioning plans for a spent fuel management facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body.*

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 licensing procedure. Applications for changes to the licensed condition of the facility must either be submitted to the supervising authority for approval or in case of significant modifications to the licensing authority. Before further use or demolition of the storage building, proof that the building is either not contaminated or has been decontaminated sufficiently and is free of inadmissible activation must be furnished in the form of measurements. The requirements under construction and waste law must also be observed. The supervisory authorities of the *Länder* (Federal States) ensure that a corresponding exchange of expertise takes place at the level of supervision and with the experts also consulted.

## Article 10 (Disposal of spent fuel)

*Article 10*

*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 assemblies from nuclear power plants are intended to be put in direct final storage, with the exception of those delivered to a reprocessing plant up until 30 June 2005. After 30 June 2005, the transportation of fuel assemblies for the purpose of reprocessing will be prohibited.

Under the direct disposal concept, spent fuel assemblies are to be packed in containers 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 containers are then to be sealed and emplaced in galleries or bore holes in deep geological formations. The prototype of a facility for the packaging of the spent fuel assemblies in containers that are suitable for disposal has been erected.

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

## Section H. Safety of Radioactive Waste Management

### Article 11 (General safety requirements)

*Article 11*

*Each Contracting Party shall take the appropriate steps to ensure that at all stages of radioactive waste management individuals, society and the environment are adequately protected against radiological and other hazards.*

*In so doing, each Contracting Party shall take the appropriate steps to:*

- *(i) ensure that criticality and removal of residual heat generated during radioactive waste management are adequately addressed;*
- *(ii) ensure that the generation of radioactive waste is kept to the minimum practicable;*
- *(iii) take into account interdependencies among the different steps in radioactive waste management;*
- *(iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;*
- *(v) take into account the biological, chemical and other hazards that may be associated with radioactive waste management;*
- *(vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;*
- *(vii) aim to avoid imposing undue burdens on future generations.*

The remarks on Article 4 apply analogously to Articles 11 (i) to (vii).

### Article 12 (Existing facilities and past practices)

*Article 12*

*Each Contracting Party shall in due course take the appropriate steps to review:*

*Article 12*

- *(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;*

In Germany, all facilities existing at the time when the Joint Convention entered into force have already demonstrated in principle their adequate safety within the licensing procedures and their operation. Construction and operation have to be such that the necessary precaution against damage has been taken in line with the state of the art in science and technology. The competent licensing authority has confirmed this through granting the licence. Following the commissioning of a facility, its safety is regularly reviewed, which is yet again done by the authorities as part of their nuclear supervisory role.

The general requirements regarding the precautionary measures to be taken are stipulated in the Atomic Energy Act (AtG) [1A-3], in the Radiation Protection Ordinance (StrlSchV) [1A-8] and in other legal and subordinate regulations. The safety requirements of the IAEA, as included e.g. in [IAEA 00a] or [IAEA 95], are also observed.

The protection targets extend to the protection of the local population in the vicinity of the facility, protection of the environment, protection of the operating personnel, and the protection of property against the effects of ionising radiation (cf. the remarks on Article 11 and 4, respectively). Compliance with these protection targets also satisfies the requirements of the Convention. This is ensured by nuclear licensing and supervision.

In the following account, a distinction is made between facilities for the treatment and storage of heat-generating waste and waste with negligible heat generation.

**Safety of Facilities for the Treatment of Heat Generating Waste**

In Germany, there exists one facility for the vitrification of HAWC solutions and two storage facilities for solidified heat-generating waste.

The HAWC solutions generated during the operation of the Karlsruhe Reprocessing Plant (WAK) are currently being stored and are intended for vitrification. The Karlsruhe Vitrification Plant (VEK) was built for this purpose. This facility is now complete and is scheduled to start operating during the first quarter of 2006.

The safe storage of the HAW solutions is ensured by

- the safe enclosure of the activity by two barriers,
- the removal of the decay heat, and
- the removal of the radiolysis gases via the exhaust system.

The storage tanks are also protected against external impacts.

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

In terms of equipment technology, process control and handling techniques, the methods used for the vitrification of HAWC at the newly-built VEK plant is based on the comprehensive experience gleaned from the PAMELA vitrification plant in Mol and at the WAK, as well as from cold-test research facilities, and complies with the state of the art in science and technology.

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

During construction, the supervisory authority performed checks within the framework of quality assurance to verify whether the specified requirements for systems and components were met. The results were recorded in inspection reports. Independent experts were involved in this task.

During operation, key safety-relevant systems and components are rechecked at regular intervals. During these checks, the inspectors verify whether they still meet the specified requirements. In addition, wearing parts (e.g. seals) are regularly replaced within the context of preventive maintenance.

Interim storage facilities for heat-generating radioactive waste exist at Gorleben as well as within the grounds of the Karlsruhe Research Centre. At the Gorleben transport container storage facility, not only spent fuel assemblies but also vitrified high-active waste from reprocessing is stored in transport and storage containers. Here, the same safety requirements apply as those described in the remarks on Article 5. At Karlsruhe, the LAVA facility houses the fission product solutions from former operations of the reprocessing plant. These are to be vitrified in the VEK in the coming years. In addition, there is heat-generating waste that is stored in a storage bunker with remote handling systems. The safety of this storage facility has been checked as part of the licensing procedure and is subject to authority supervision over its entire operating period.

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

One key central precaution is the confinement of radioactive substances by several barriers connected in series. These may either be material barriers, such as the tank walls, the cell walls, the stainless steel canister and the vitreous matrix, as well as the outer building, or process engineering barriers, such as directed airflows of the waste air from the room and cells caused by pressure differences.

The number and technical design of the barriers are tailored to the nature (solid, liquid, gaseous) and activity inventory of the substances to be retained.

The efficiency of the barriers is monitored in the cells, work rooms and operating rooms by devices for the detection of leakages, pressure deviations and airborne radioactivity in the cells.

**Safety of Facilities for the Treatment of Waste with Negligible Heat Generation**

Radioactive waste with negligible heat generation is put in interim storage, either at the place where it arises or in a central facility, until it can be disposed of in a repository. In most cases, the waste is stored in conditioned form. Conditioning, which is carried out in stationary or mobile facilities, serves the purpose of transforming radioactive waste into a form that is suitable for final disposal. As there is no repository available in Germany for the time being, one has to assume that the waste will remain in interim storage for a longer period of time. Conditioning therefore 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 Article 15 i).

Different facilities and methods are used for the conditioning of radioactive waste (cf. Table L-5). In the case of liquid waste, the radioactive components are separated through evaporation, ion exchange, filtration or chemical precipitation. Solid waste is burnt or compacted if necessary in order to reduce its volume. Afterwards, it is safely confined in containers. The conditioning plants are almost all assigned to specific nuclear facilities and, together with the other facilities and industrial premises, are subject to licensing, monitoring and supervision by the competent local authority. The safety of the conditioning plants was assessed in the licensing procedure. During operation, regulatory control ensures that safety-related requirements are fulfilled.

The confinement of radioactive substances during the storage of radioactive waste is ensured by a system of technical barriers and supplementary measures. This can be achieved with a variety of different approaches and may include, for example, integration into the matrix of the waste product, confinement in waste containers or, where applicable, the barrier function of buildings and ventilation systems with retention devices. Overall, safe enclosure can be achieved by one barrier or the combined effects of several barriers.

Facilities for the interim storage of radioactive waste with negligible heat generation and residual waste are generally designed for the handling and storage of sealed radioactive substances – in other words, the waste packages perform the function of safe activity confinement. In order to comply with the corresponding specifications, the waste packages are subjected to product control. This is ensured by means of monitoring and supervision.

Within the context of analysing hazardous incidents, external impacts are also taken into consideration. On this basis, the authority decides which precautionary measures are to be taken for the facility.

As there is no repository available in Germany for the time being, the waste will have to be stored for longer periods of time in the interim storage facilities. 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 repackaging 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 Section 7 StrlSchV, to be issued by the respective competent *Land* authority.

In contrast, radioactive waste from research, industrial or medical application may be surrendered to State collecting facilities (cf. State collecting facilities of the *Land* Berlin as an example in Figure H-1) unless it is stored at the originator's site. According to Section 9a AtG [1A-3], these State collecting facilities have to be provided by the *Länder* for the radioactive waste arising on their territory. The handling of the radioactive waste within the State collecting facilities as well as any deviations of the handling procedures laid down in the licensing documents (Annex II Part A StrlSchV) also require licensing according to Section 7 StrlSchV by the competent *Land* authority. Checks during the licensing procedure ensure that relevant safety requirements are fulfilled (cf. the remarks on Article 15). If the radioactive waste is not only stored but also treated at the State collecting facility, the regulations have to be applied accordingly (cf. the remarks on Article 15).

An application to the State collecting facilities for the delivery of radioactive wastes must be submitted in writing by the delivering party and accompanied by a waybill. On the basis of these documents, checks are made to ascertain whether the preconditions for acceptance of the radioactive waste have been met. The acceptance criteria of the State collecting facilities differ from one *Land* to another, and are laid down in the respective regulations for use. They depend on the respective licensing situation, and on the availability of conditioning equipment. Recommendations for the interim storage of low- and medium-active waste are contained in [4-3] (cf. the remarks on Article 15). These recommendations include visual inspection of the outer surfaces of certain waste packages, and separate storage and repeated checks with visual inspection for unconditioned wastes. Safety-related findings must be notified to the *Land* authority responsible for the interim storage.

If the radioactive wastes fail to meet the preconditions stipulated in the respective regulations for use of the State collecting facility, the latter may refuse to accept them, and will report this to the supervisory authority responsible for the delivering party. In such cases, the wastes will remain in the hands of the delivering party until transformed into a condition conforming to the regulations for use, and the State collecting facility is willing to accept it. Alternatively, the radioactive wastes may be delivered by special agreement, subject to the consent of the competent supervisory authority. After acceptance, a further incoming inspection is performed to verify once again that the acceptance criteria have been met.

Figure H-1: Exit hall of the "Central radioactive waste treatment and disposal facility" (Zentralstelle zur Behandlung und Beseitigung radioaktiven Abfalls - ZRA) at the Hahn-Meitner Institute, with the interim storage volume as at September 2004. Being a State collecting facility of the *Land* Berlin, the ZRA accepts low- and medium-active waste arising from uses in industry and trade, medicine, and research and teaching. (Copyright: HMI)

When the waste is surrendered to the State collecting facility, it passes into the ownership of the latter. This also applies to raw waste. The waste originator's duties in connection with conditioning are thus adopted for this waste by the operator of the State collecting facility. This procedure ensures that waste packages that are stored over a longer period at a State collecting facility have the same quality standard as those in an interim storage facility for waste from nuclear installations (Section 74 StrlSchV).

The acceptance criteria are adapted in line with the latest state of the art in science and technology. Each year, the individual operators of State collecting facilities hold a meeting for the purpose of exchanging information.

*Article 12*

*(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.*

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. A cataloguing and categorisation of such legacy sites has largely been completed in Germany.

Past practices with respect to Uranium mining and milling have been carried out at a large number of sites especially in Saxony which have been discontinued prior to 21 December 1962 and therefore do not fall into the responsibility of the Wismut GmbH for carrying out remediation measures (cf. the separate report on remediation work of Wismut GmbH). According to the Federal Office for Radiation Protection, the residues present at those sites amount to about $46.5 \cdot 10^6$ m³ of heaps and about $4.7 \cdot 10^6$ m³ of mill tailings. A register of radiologically relevant sites contaminated from mining activities has been established. Remediation of contaminated sites in Saxony has commenced in 2003 on the basis of a administrative agreement between the Federal Government and the Free State of Saxony.

The German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety is currently preparing the regulatory framework for the evaluation of the requirements for remediation of radioactive legacy sites.

## Article 13 (Siting of proposed facilities)

*Article 13*

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 sub-sections. 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 summarized here and reference is made to the appropriate sections.

### Siting of Proposed Radioactive Waste Management Facilities

For facilities for radioactive waste management which require a licence according to the Atomic Energy Act (AtG), 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 Section 7 of the Radiation Protection Ordinance (StrlSchV) [1A-8], depending on the nature of the facility. In contrast to the facilities mentioned above, this licensing procedure is not regulated by the Nuclear Licensing Procedures Ordinance (AtVfV) [1A-10], but is carried out by the competent licensing authority of each Federal State as described in the following.

The licensing requirements which must be met by such a facility are described in Section 9, para. (1) of the StrlSchV. With respect to the siting of such facilities, the following licensing requirements are particularly relevant:

- the necessary protection must be ensured against disruptive action or other interference by third parties,
- the choice of the site must not conflict with overriding public interests, particularly in view of its environmental impacts.

The required documentation and information depends on the type of facility and in particular on whether or not an environmental impact assessment (EIA) is necessary. According to Appendix 1 of the Environmental Impact Assessment Act (UVPG) [1B-14], an EIA is required for:

- 11.3: Construction and operation of a facility or installation for the handling or management of irradiated fuel assemblies or highly radioactive waste.

By contrast, the following facilities or installations (see Appendix 1 of the UVPG) require a general preliminary assessment of each individual case according to Section 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 Section 50 of the Radiation Protection Ordinance, such activities are defined as $10^7$ times the exemption levels as specified in Appendix III, Table 1, column 2 of the StrlSchV in the case of unsealed radioactive substances and $10^{10}$ times the exemption levels as specified in Appendix III, Table 1, column 2 of the StrlSchV in the case of sealed radioactive substances).

This general preliminary assessment includes a rough review of the individual case with respect to potential substantial negative environmental impacts, with due regard for the criteria listed in Appendix 2 of the UVPG (including characteristics of the project, site, possible effects). Based on the outcome of this preliminary assessment, the competent authority will determine whether or not an environmental impact assessment is required.

Where the cases listed above pertain to the planned radioactive waste management facility or installation and if an EIA is required for the facilities or installations listed in point 11.4, then the type of information outlined in the remarks on Article 6 1. (i) and (ii) must be provided. This also implies the involvement of the general public in accordance with Section 9 of the UVPG (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 as specified in Sections 7 and 8 of the UVPG (cf. the remarks on Article 6 1. (iv)).

**Site Planning for Disposal**

According to Section 9b of the Atomic Energy Act (AtG), the plan approval procedure for a repository is to be carried out according to the relevant provisions of the Nuclear Licensing Provisions Ordinance (AtVfV). The licensing procedure according to nuclear law in connection with the required environmental impact assessment ensures that the requirements of Article 13 are met (cf. the remarks on Article 6 (i) to (iv)).

In the current legal situation, a procedure for the selection of a repository site has not yet been specified as the decision process within the Federal Government has not yet been concluded. It has been recognised, however, that this is an essential requirement for the search for a suitable site. For this reason, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) established in February 1999 the *Arbeitskreis Auswahlverfahren Endlagerstandorte - AkEnd* (Committee on a Site Selection Procedure for Repository Sites), giving it the task to develop a logical procedure for the selection of sites for the disposal of all kinds of radioactive waste in Germany and to elaborate criteria for the identification of sites that are both suitable for safe disposal and at the same time accepted by the general public. The working results of the AkEnd have been presented to the BMU and are currently being discussed within the Federal Government.

The selection procedure proposed by the AkEnd in its Final Report [AkEnd 02] envisages a step-by-step process whereby areas, site regions and finally sites that provide particularly favourable conditions for subsequent proof of suitability and confirmation in a licensing procedure are determined on the basis of concrete and quantified geoscientific and - for the first time ever – socio-scientific criteria. The starting point of the procedure is to be the entire territory of Germany, without any prior specification of certain areas or a special type of host rock. The selection procedure recommended by the AkEnd consists of five consecutively developing procedure steps, each of which is attributed to certain criteria together with their rules of application and various forms of citizens' participation (cf. Figure H-2).

Figure H-2: Selection procedure for repository sites according to the AkEnd proposal [AkEnd 02]

| Procedure steps | Proceeding, criteria, assessments | Instruments of citizens' participation |
|---|---|---|
| **1st step**<br>Objective: Identification of areas fulfilling specific minimum requirements | **For Step 1**<br>• Geoscientific exclusion criteria | **For the overall procedure (Steps 1 - 5)**<br>Participation by information and control:<br>• Establishment of an information platform<br>• Control committee verifies adherence to the rules of the procedure |
| **2nd step**<br>Objective: Selection of partial areas with particularly favourable geological conditions | **For Step 2**<br>• Geoscientific weighing | |
| **3rd step**<br>Objective: Identification and selection of site regions for exploration from the surface<br>Step backwards, if required ∆ | **For Step 3**<br>• Planning-scientific exclusion criteria<br>• Socio-economic potential analysis<br>• Planning-scientific weighing criteria<br>• Specification of programmes for exploration from the surface<br>• Willingness to participate regarding exploration from the surface<br>• Geoscientific and mining aspects | **As from Step 3**<br>• Citizens' forum as a central element of participation<br>• Centre of competent experts supports citizens' forum<br>• Round table of stakeholders<br>• Determination of willingness to participate in Steps 3, 4 and possibly by vote<br>• Preparation of regional development concepts<br>• Local council/councils take/s final decision |
| **4th step**<br>Objective: Determination of sites for underground exploration<br>Step backwards, if required ∆ | **For Step 4**<br>• Exploration from the surface<br>• Orienting safety assessment<br>• Development of test criteria<br>• Willingness to participate regarding underground exploration programmes | |
| **5th step**<br>Objective: Decision on a site<br>Step backwards, if required ∆ | **For Step 5**<br>• Underground exploration<br>• Application of test criteria<br>• Safety case<br>• Comparison of the different sites explored | |
| **Repository site**<br>for licensing procedure | | |

**Article 14 (Design and construction of facilities)**

| *Article 14* |
| --- |
| *Each Contracting Party shall take the appropriate steps to ensure that:* |

| *Article 14* |
| --- |
| *(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;* |

Regarding the design and construction of radioactive waste management facilities, both the requirements of relevant acts and ordinances (such as the Atomic Energy Act (AtG) [1A-3] and the Radiation Protection Ordinance (StrlSchV) [1A-8]), and the content and recommendations of sub-statutory rules and regulations are duly taken into account and applied with regard to radiological aspects (e.g. KTA 1301.1; see enclosed list of KTA nuclear safety standards).

The realisation of these requirements creates the prerequisites for compliance with the radiation exposure limits for persons in Categories A and B who are exposed to radiation by virtue of their occupation, as well as for the population in the surrounding area during operation of the facility, as stipulated in the Radiation Protection Ordinance.

**Radiological Protection of Operating Personnel**

The measures to ensure the radiological protection of operating personnel which must be taken into account during the design and construction of facilities for the treatment of radioactive waste refer, in particular, to structural measures regarding the arrangement and design of the rooms in the controlled area of the facility. In this respect, the emphasis is on the arrangement and 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 licensing procedure by the competent authority.

**Radiological Protection of the Population during Specified Normal Operation**

The radiological protection of the population during specified normal operation is ensured during the planning and construction of radioactive waste management facilities by their structural and technical design. In addition to shielding effect of the walls of the controlled area already mentioned above under the aspect of radiological protection of operating personnel, which also serves to limit direct radiation at the site and in the vicinity of the facility in accordance with Section 46 of the Radiation Protection Ordinance (StrlSchV), appropriate technical equipment must also be provided to limit the release of radioactive substances with air or water, in order to comply with the limits specified in Section 47, para. 1 of the StrlSchV for individual members of the local population in the vicinity of the facility. Such equipment comprises retention devices for airborne radioactive substances, as well as treatment facilities for contaminated waters and transfer tanks for waters from the controlled area. Moreover, the prerequisites for the measurement of releases and their nuclide-specific balancing are ensured by means of corresponding measurement, sampling and analysis methods.

**Radiological Protection of the Population in Case of an Accident or Hazardous Incident**

In accordance with Section 50 of the Radiation Protection Ordinance (StrlSchV), the conceptual planning of a radioactive waste management facility (interim storage facility, conditioning facility) includes structural and technical protective measures, with due regard for the potential extent of any damages, to limit radiation exposure caused by the release of radioactive substances into the environment in case of an accident or hazardous incident. The licensing authority defines nature and scope of the protective measures with reference to each individual case, particularly with regard to the hazard potential of the facility and the likelihood of an incident or accident occurring.

According to Section 49 of the StrlSchV, the design of structural or other technical measures to protect against incidents in or around a repository for radioactive waste must be based on a maximum effective dose of 50 mSv caused by the release of radioactive substances into the environment in the least favourable case. This requirement remains applicable until decommissioning. Individual dose limits are to be applied for specified organs. Further details can be found in Table F-1. The state of the art in science and technology is decisive for the adequacy of precautionary measures against accidents.

At the same time, the measures to protect the population against radiation also serve to ensure the protection of the environment.

*Article 14*

*(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;*

The decommissioning of radioactive waste management facilities is taken into account at the design stage and during their construction, thanks to the analogous application of the stipulations and recommendations contained in the statutory and substatutory rules and regulations on the decommissioning of nuclear installations (cf. [3-73]). With regard to facilities for the dry storage of HAW canisters, Guidelines [4-2] must also be applied. These guidelines state that an interim storage facility must be designed and executed in such a way that it can either be decommissioned or re-used or removed in compliance with the radiological protection regulations.

Regarding the planning and construction of radioactive waste management facilities, the design ensures that the decommissioning of these facilities at a later stage takes place with due regard for the radiological protection of operating personnel and adherence to the radiological protection regulations. In particular, structural prerequisites must be created in order to ensure the use of specific decontamination and dismantling methods, including remote-controlled methods, during the subsequent decommissioning of the facility.

For this reason, a corresponding decommissioning concept must be available at the design and construction stage of the facility. This concept includes specifications regarding the intended decommissioning option, which depends primarily on whether the radioactive waste management facility is being be constructed as part of a major nuclear installation, thus being integrated into decommissioning procedure of this facility, or whether it constitutes a separate site, thus entailing an independent decommissioning procedure directly related to this facility. Further decisive parameters of the decommissioning concept are determined by the composition of the radioactive waste treated at the facility, in particular by whether or not it involves waste containing nuclear fuel.

Within the context of the decommissioning concept, the operator plans the decommissioning procedure, assuming that any residual quantities of the radioactive waste treated at the facility have been removed beforehand. The decommissioning concept also incorporates the requirements with regard to decontamination and dismantling methods and thus the radiological protection of the personnel. Since activation by neutrons can be virtually excluded, these requirements result from the contamination of components. In this respect, however, it is important to consider that during treatment of fuel-containing wastes or wastes with other alpha-emitters, contamination from alpha-emitting nuclides is also present.

The requirements relating to the proposed decontamination methods take into account the minimisation of individual and collective doses to achieve a condition adequate for the performance of decommissioning and dismantling work, as well as the reduction of volume and the recovery of residues as harmlessly as possible, with due regard for the secondary waste generated.

The requirements relating to the dismantling methods depend on the technological task (material, size of the components, environmental conditions, accessibility), the radiation protection conditions (existing activity, potential for aerosol formation, risk of contamination, confinement of mobile activity, limitation of the individual and collective dose), and the intended subsequent treatment in the form of residual waste for reuse, conventional disposal, or disposal as radioactive waste.

The decommissioning of the Karlsruhe Vitrification Plant (VEK), which is currently under construction, will be achieved primarily using the equipment required for operation and has already been incorporated into the design of the facility. The planned steps and measures for decommissioning of the facility were described by the applicant in his safety case.

*Article 14*

*(iii) at the design stage, technical provisions for the closure of a disposal facility are prepared;*

Upon termination of the operational phase, a repository in deep geological formations must be safely sealed against the biosphere in the long term.

As a licensing prerequisite, Section 9b, para. 4 of the Atomic Energy Act (AtG) in connection with Section 7, para. 2, subpara. 3 stipulates that “the necessary precautions have been taken in the light of the state of the art in science and technology to prevent damage resulting from the erection and operation of the installation”. Regarding nuclear safety, the Safety Criteria [3-13] for the Permanent Storage of Radioactive Waste in a Mine of 1983 formulate this requirement in more concrete terms:

“After closure, radionuclides which could reach the biosphere as a result of transport processes from a sealed repository which cannot be completely excluded must not lead to individual doses that exceed the levels stipulated in section 45 of the Radiation Protection Ordinance.” Section 45 of the former version of the Radiation Protection Ordinance (now Section 47 of the Radiation Protection Ordinance of July 2001) limits the annual radiation exposure of individual members of the general public caused by discharges of radioactive materials with air or water from nuclear facilities or installations. The Ordinance does not stipulate expressly any limits for radiation exposure caused by radioactive material released from a repository in its post-closure phase. For this reason, when conducting site-specific investigations into long-term safety, procedures are based on Section 47 of the Radiation Protection Ordinance.

Due to requirements in other legal areas, it is necessary to ensure that damaging 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 inventory, the emplacement technique and the backfill materials. With the aid of a comprehensive site-specific long-term safety analysis including scenario analyses, 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 backfill 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.

*Article 14*

*(iv) the technologies incorporated in the design and construction of a radioactive waste management facility are supported by experience, testing or analysis.*

There is no difference between the requirements governing the technologies applied to the design and construction of radioactive waste management facilities and those for facilities for the treatment of spent fuel assemblies. As such, the remarks on Article 7 (iii) apply in full to Article 14 (iv).

**Article 15 (Assessment of safety of facilities)**

*Article 15*

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

*Article 15*

*(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;*

Assessment of the safety of radioactive waste management facilities (interim storage facilities for radioactive wastes, and vitrification and other conditioning facilities, repositories), and the assessment of environmental impacts prior to construction of such a facility, are carried out as part of a licensing procedure (cf. the remarks on Article 19).

Under Section 7 of the Radiation Protection Ordinance (StrlSchV) [1A-8], the handling of radioactive materials in nuclear facilities for the management of radioactive wastes requires a licence.

Being a special case, the erection of vitrification facilities must be licensed in accordance with Section 7 of the Atomic Energy Act (AtG) [1A-3], since nuclear fuels will be treated or processed in such facilities. The essential features of the safety assessment in the licensing procedure pursuant to Section 7 of the AtG are outlined in the remarks on Article 8, and apply *mutatis mutandis* to the licensing procedure for facilities for the vitrification of highly radioactive wastes.

Whereas the licence pursuant to Section 7 of the AtG combines the licences required for the erection and operation of the nuclear facility and for the handling of nuclear fuels (cf. the remarks on Article 8), Section 7 of the Radiation Protection Ordinance regulates only the handling of radioactive materials. A building permit under the applicable building code must also be applied for.

Applications for licences under the Atomic Energy Act must be submitted to the respective competent authority of the *Land* (Federal State). The application must outline the extent to which the nuclear facility possesses the required safety characteristics, and conforms to the specifications of the applicable rules and regulations. In the licensing procedure under Section 7 of the Radiation Protection Ordinance (StrlSchV), the documents listed in Appendix II, Part A, of that Ordinance must be enclosed with the licence application. The preconditions for a licence for handling radioactive materials are governed by Section 9 of the StrlSchV. They are described in detail in the remarks on Article 13.

According to Section 12b of the Atomic Energy Act, the competent authorities are required to investigate the reliability of the persons responsible for the handling of radioactive materials, in accordance with the Reliability Assessment Ordinance (*Atomrechtliche Zuverlässigkeitsüberprüfungs-Regulation = AtZüV*) [1A-19], so as to safeguard against unauthorized actions that might lead to a misappropriation or substantial release of radioactive materials.

Among other things, one licensing condition is that on handling radioactive waste, the equipment must be available and the measures taken in accordance with the state of the art in science and technology to ensure that the protective provisions are observed (Section 9 StrlSchV). The standards of the Nuclear Safety Standards Commission (*KTA*) and the German Standards Institute & German Association of Electrical Engineers (DIN/VDE) are used as the basis for checking the licensing requirements, and are applied *mutatis mutandis*. During the course of verifying the licensing requirements, the competent licensing authority may call upon the services of independent experts in accordance with Section 20 of the Atomic Energy Act.

For the adaptation to the state of the art in science and technology, the competent authority may impose additional requirements for licensing during the operational lifetime of the facility.

For example, as a result of deficiencies found during operation time 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).

According to the Environmental Impact Assessment Act (UVPG) [1B-14], an environmental impact assessment is mandatory for nuclear facilities designed to store radioactive wastes for more than ten years at a location other than that where they were generated, and for nuclear facilities requiring a licence under Section 7 of the Atomic Energy Act (AtG). However, it also applies to facilities that do not require an environmental impact assessment that all radiological effects have to be examined within the framework of the safety assessments of the licensing procedure. More information on the EIA Act can be found in the remarks on Article 13 and Article 6.

In addition, the Environmental Impact Assessment Act provides for general screening of individual cases in the case of nuclear facilities for the storage, handling, or processing of radioactive wastes whose activity reaches or exceeds specified values. For such facilities, an environmental impact assessment must be performed if the competent authority feels that the project may have substantial adverse environmental impacts.

In 2002, the Reactor Safety Commission prepared safety requirements 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 environmental impacts. 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 radioactive substances. The waste containers thus assume the function of 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 must be stable at the temperatures reached.
  Within the framework of process qualification, the entire conditioning process 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 caused by 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 StrlSchV. Access to and legibility of the documentation has to be guaranteed until the waste is emplaced in a repository or released according to Section 29 StrlSchV.
- According to the RSK safety requirements, she scope of the administrative monitoring measures to be performed for the compliance with the protection goals during the interim storage at each waste package and in the storage room shall be as small as possible, taking into consideration the safety-related requirements. In view of the longer-term interim storage, the waste packages shall be maintenance free.

The requirements for the waste containers result in particular from the safety analyses and are specified in the technical acceptance criteria of the interim storage facilities. In most cases, the requirements of the transport regulations also have to be observed, or compliance has to be ensured for the consignment at a later stage by means of an additional outer packaging. Waste containers and packagings for interim storage are licensed by the respective competent authority. Among others, the following requirements for waste containers regarding longer-term interim storage ensue from [4-3]:

- The design of the waste containers has to be such that their handling can also be ensured during and after interim storage. In this respect, long-term stability of the container materials has to be taken into consideration. The long-term integrity has to be ensured by means of an adequate design of the waste containers (e. g. corrosion protection, thick container walls). The potential for any impairment of the container integrity caused by impacts from the interior of the container (characteristics of the waste product) and from outside (e. g. atmospheric conditions of the interim storage facility) has to be considered.
- As far as the waste containers are not suitable for a longer-term interim storage without any doubt due to their design, recurrent controls of the waste containers by non-destructive tests (e. g. visual inspections) shall be performed. To enable these controls, accessibility has to be

ensured in the interim storage facility (e. g. by providing alleys between the package stacks or separate storage of packages). The scope of the controls shall be defined individually.

The structural works are to be built according to the respective building codes of the *Länder* and according to the generally recognised engineering rules. Concerning the storage buildings, the RSK recommendation [4-3] contains i. a. the following requirements:

- 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 Section 49 StrlSchV have to be observed for on-site interim storage facilities at nuclear power plants; for other interim waste storage facilities, the requirements of Section 50 StrlSchV apply. The kind and scope of the protective measures and the protection targets are to be specified in a general administrative provision pertaining to Section 50 StrlSchV. This general administrative provision has yet to be drawn up.
- Within the framework of an incident analysis it has to be examined which operational disturbances and incidents may occur during the storage of low- and medium-active waste. On the basis of this analysis, the design basis accidents for storage shall be derived and distinguished from operational disturbance belonging to abnormal operation and residual-risk events. Human errors shall be considered in the analysis. The following plant-internal events (internal impacts) are generally to be considered as design basis accidents:
  - mechanical impacts (drop of a waste package or drop of a load onto a waste package)
  - fire
  - failures of safety-relevant systems and equipment (loss of preferred power, failure of instrumentation and control systems as well as of hoisting gear and transport vehicles)

  Also, the following external events have to be taken into account in the analysis of potential impacts as a rule:
  - natural external events, e. g. storm, rain, snowfall, freeze, lightning, flooding, forest fires, earthquakes, landslides.
  - man-induced external events, e. g. impacts of harmful substances, blast waves caused by chemical reactions, external fires spreading to the interior, damage by mines caving in, aircraft crashes.

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. This difference is explained by the lack of standard federal regulations.

The feasibility in principle of decommissioning a radioactive-waste management facility is considered within the context of the licensing procedure. Decommissioning requires a licence under Section 9 of the Atomic Energy Act (AtG) or Section 7 of the Radiation Protection Ordinance (StrlSchV).

*Article 15*

*(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;*

**Assessment of Safety before Construction of a Disposal Facility for the Period Following Closure**

Section 9b as well as Section 7, para. 2, no. 3 of the Atomic Energy Act (AtG) stipulate that the necessary precautions must be taken according to the state of the art in science and technology to prevent damage from ionising radiation. These precautions are also pertinent to the period following closure of a repository. As the disposal of radioactive waste in Germany is defined as the maintenance-free, safe emplacement of these materials for an unlimited period of time, the long-term safety assessment is of particular importance within the licensing procedure.

The objective of radiation protection is based on the dose limits set out in Section 47 of the StrlSchV (cf. the remarks on Article 14 (iii)).

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 Section 47 of the StrlSchV and the associated General Administrative Provision [2-1]. Evidence is additionally based on an assessment of the overall geological situation of the site.

The current state of the art in science and technology is decisive when specifying a forecasting period for the required precautionary measures (isolation period). In other words, all relevant scientific and technological knowledge and experience must be taken into account. With the aid of a geo-scientific long-term forecast, an isolation potential of > $10^5$ years has been calculated for the Schacht Konrad repository as a repository for radioactive waste with negligible heat generation.

Point 5.2 of the Safety Criteria for the Permanent Storage of Radioactive Waste in a Mine [3-13] stipulates that

> ".... site-specific safety analyses must be performed in accordance with scientific methods. Within the scope of the safety analysis, sub-systems and scenarios are emulated by means of suitable models using sufficiently conservative assumptions."

This implies that releases of radionuclides and non-radioactive contaminants from the repository through the geosphere into the biosphere, as well as the resultant possible radiation exposure for humans and the effects on groundwater, must be evaluated and assessed within the context of model calculations.

**Assessment of Impacts on the Environment**

Section 9b of the Atomic Energy Act (AtG) stipulates that a plan approval procedure (licensing procedure) is mandatory for repositories for radioactive waste. The plan approval notice may only be granted if the prerequisites listed in the aforementioned section of the AtG have been met by the applicant (cf. the remarks on Article 4 (i) to (iv)). This also includes consideration of the common good and other provisions of public law, particularly with respect to the environmental impacts.

The Nuclear Licensing Procedures Ordinance (AtVfV) [1A-10] and the Administrative Procedures Act (VwVfG) regulate the design and implementation of the plan approval procedure. In addition, the Environmental Impact Assessment Act (UVPG) requires the performance of an environmental impact assessment.

Stipulating that the state of the art in science and technology is a prerequisite for the plan approval notice ensures that the safety assessments and the environmental impact assessment are up-to-date at the time of issuing the plan approval notice.

*Article 15*

*(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).*

Under Section 19 of the Atomic Energy Act (AtG), the handling and trafficking of radioactive substances is subject to government supervision. An assessment of the safety and the environmental impacts prior to commissioning of the nuclear facility occurs within the context of supervision which accompanies construction under the Atomic Energy Act.

If material deviations in the handling as specified in the licensing documents occur between the time of licensing until the commissioning of a facility for the treatment of radioactive waste, renewed licensing under Section 7 of the Radiation Protection Ordinance (or Section 7 of the Atomic Energy Act in the case of vitrification facilities) is required (cf. the remarks made on Article 8 ii). Modification licences are applied for by the operator of the nuclear facility affected, sometimes within the framework of a nuclear regulatory authority order, at the competent licensing authority. The documents to be submitted together with the licence application have to reflect the state of the art in science and technology regarding the scope of effects of the part to be modified. The safety assessment carried out by the safety authority also has to be based on the state of the art in science and technology. Where applicable, in the case of projects requiring an environmental impact assessment under Section 3e of the Environmental Impact Assessment Act (UVPG), the assessment of environmental impacts must be repeated, e. g. if the alteration applied for could entail substantially altered impacts on the environment. This means that public participation will again be necessary as part of the environmental impact assessment.

## Article 16 (Operation of facilities)

*Article 16*

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

*Article 16*

*(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;*

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 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.

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.

*Article 16*

*(ii) operational limits and conditions, derived from tests, operational experience and the assessments as specified in Article 15 are defined and revised as necessary;*

All operational processes and the measures to be taken in case of an incident or accident are outlined in an operating manual, or in the case of a repository, in a mine book/operating manual, in form of clear operating instructions. These pay particular attention to all aspects affecting safety and define operational limits and conditions. Furthermore, the procedure in case of modification or supplementation of components and processes must also be specified. The operating manual forms part of the licensing documents and is therefore subject to examination. This ensures that operatives are able to initiate and perform the necessary measures swiftly and competently in case of abnormal operation or incidents. This procedure is subject to regulatory supervision.

*Article 16*

*(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;*

Regulatory supervision ensures observance of the procedures on operation, maintenance, monitoring, inspection and testing established in the nuclear licensing procedure for a radioactive waste management facility (cf. Table L-5 to Table L-10) as well as the consideration of the safety requirements for the longer-term interim storage of low- and medium-active waste [4-3].

For the treatment of radioactive waste, conditioning plants are used in this context that are subjected to qualification by the BfS, or the conditioned waste is subjected to product control procedures to ensure its suitability for final disposal (cf. the remarks made on Article 23 "Quality Assurance").

For storage facilities it applies in particular that the waste is subjected to incoming inspection prior to any form of treatment or emplacement. The incoming inspection serves the purpose of verification and must facilitate the following evidence:

- Identification control: The incoming inspection verifies whether the wastes are the same as those declared for acceptance.
- Fulfilment of acceptance criteria: The incoming inspection ensures that the acceptance criteria defined in the licence are fulfilled. For this purpose, reference may also be made to the quality-assured data of the conditioner.
- Verification of the data stated by the delivering party: The incoming inspection checks specific waste parameters independently from the data supplied by the delivering party. Specific parameters may include, for example, mass, dose rate and surface contamination.

As a general rule, the following aspects are controlled for the purposes of emplacement operation:

- Mass, dose rate and surface contamination of the waste packages,
- Condition and labelling of the waste packages, and

- Compliance with declared data.

Furthermore, the following is also observed:

- In the case of non-compliance, extended controls are performed.
- The incoming inspections are only performed by trained personnel.
- 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 must be available to ensure fulfilment of the safety requirements, and must be subject to regular training. With regard to personnel, a distinction is made between the following cases:

- Management and storage facilities belonging to a nuclear installation which is 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 instruction manual.

Due regard is given to the development and promotion of a pronounced safety culture. This is particularly applicable to facilities where personnel activities are required relatively seldom or where changing personnel are deployed for different tasks. With regard to long-term operation of the storage facilities, it is assumed that changes of personnel are required. In this respect, measures are taken to ensure that the required personnel resources are available in order to maintain a sustainable safety culture. This is achieved by long-term personnel planning and careful planning with regard to the maintenance of experience.

Different emergency procedures may be required, depending on the type of management or storage facility and the wastes stored. Based on the possibilities for the release of radioactive substances from the storage facility, an on-site emergency preparedness plan is drawn up, coordinated and agreed, where applicable, with the emergency preparedness plans of neighbouring facilities and the competent local and regional authorities. Hard copies of the on-site emergency preparedness plan are always kept available at a permanently staffed location, Further copies are submitted to the neighbouring facilities, the competent authorities and safety bodies, where applicable.

*Article 16*

*(iv) engineering and technical support in all safety-related fields are available throughout the operating lifetime of a radioactive waste management facility;*

It is already reported on the measures to ensure engineering support during the facility's operating lifetime via the provision of adequate competent personnel in the comments on Article 22 (i). The requirements for interim storage facilities ensue from the safety requirements for the longer-term interim storage of low- and medium-active waste [4-3], which stipulate that irrespective of the situation at the site, the interim storage facility must provide qualified personnel in sufficient numbers that ensures compliance with safety requirements and is regularly trained.

Recurrent tests are performed on the safety-relevant systems and equipment of the facility, such as

- conditioning facilities,
- lifting devices,
- alarm systems,
- equipment and systems for radiation protection,
- ventilation systems, where applicable.

The frequency of such testing is determined according to the safety significance of the components to be checked. Typical testing intervals are one or two years. The recurrent tests are specified in a testing manual. The results of the recurrent tests are documented.

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).

*Article 16*

*(v) procedures for characterization and segregation of radioactive waste are applied;*

The sorting and segregation of the waste (if possible, already of the raw waste) and the preparation of the associated documentation is performed initially by the waste generator or by the delivering party. If required, the waste management or storage facilities should be equipped with the necessary means for the sorting of wastes with due regard for all requirements relating to the radiological protection of personnel and the environment.

In view of the intended pre-treatment and conditioning, Appendix X StrlSchV demands the sorting and segregation of the waste. Here, a distinction is made between five main groups:

- solid inorganic waste,
- solid organic waste,
- liquid inorganic waste,
- liquid organic waste, and
- gaseous waste.

These are subdivided into further subgroups.

Moreover, the waste is also be sorted according to activity and decay period to allow the determination of suitable storage and conditioning process. In practice, the sorting, declaration and documentation is carried out according to the Waste Flow Tracking and Product Control System (AVK) or similar procedures.

*Article 16*

*(vi) incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body;*

The obligation of the licensee to report safety-relevant incidents to the regulatory body is based on the appropriate application of the Nuclear Safety Officer and Reporting Ordinance (AtSMV) or on the stipulations in connection with licensing of the facility. The reporting duties and the reporting procedure are largely identical with the situation described in the remarks on Article 9 v.

*Article 16*

*(vii) programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;*

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.

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 at facility equipment,
- improvements to or deficiencies in the conditioning process,

are examined and evaluated with regard to their transferability. Here, international reporting systems (of the IAEA and the OECD) are also considered. In this way, plant operation also makes adequate allowance for processes that occur very slowly as well as occurrences taking place rarely or only in case of certain wastes. Procedures are provided which ensure the exchange of experiences (e.g. on the basis of operating reports) between the operators on the one hand, and the competent licensing and supervisory authorities and the experts consulted by them on the other, at adequate intervals.

A monitoring concept is drawn up to allow the detection and control of long-term and ageing effects during the useful life of the storage facility. On the one hand, the monitoring concept includes an evaluation of results from previous inspections, including the experience from other facilities. On the other, it can also include special analyses that cannot be performed recurrently at regular intervals due to the effort involved and the slow speed of any anticipated detrimental changes.

The monitoring concept stipulates monitoring of the overall condition of the facility and the packages stored, and as a minimum requirement, must meet the following:

- At ten-year intervals, the licensee prepares regular reports on the condition of the storage building, the components required for storage and handling, and the waste packages. In particular, these reports should also incorporate the findings of in-service inspections. The reports include a prognosis on the continued storability of the packages and waste types, as well as on the further development of the relevant retention properties of the building.
- The condition of the storage building and the components necessary for interim storage are also subjected to a special inspection at intervals of ten years. As a minimum requirement, these should include walk-downs and appropriate measurements. In addition, recurrent subsidence measurements are performed on the storage building and evaluated with regard to long-term detrimental changes.

All operational measures, controls, inspections and modifications are subject to the supervision of the competent authorities.

*Article 16*

*(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;*

For radioactive waste treatment facilities, the remarks made on Article 9 vii apply, too.

*Article 16*

*(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.*

The Atomic Energy Act (AtG) is applicable to the Morsleben repository, which is destined for closure and backfilling, as well as to the licensed Konrad repository. However, since these are either located or planned to be located in deep geological formations, they are also subject to mining law as well as the Atomic Energy Act. According to Section 55, para. 1 of the Federal Mining Act (BBergG) [1B-15], operational plans for the construction and management of a plant may only be approved if the required precautions to facilitate reutilisation of the surface have been taken into account to the extent required under the prevailing circumstances. Furthermore, the relevant Section 7, para. 2 of the General Mining Ordinance on Underground Mines, Open-Cast Mines and Salt Mines (ABVO) [ABVO 96] stipulates that open shafts maintained in a state which is neither safe nor descendible are to be backfilled. An application for such backfilling must be submitted in a timely manner in the form of an operational plan.

This aspect of mining legislation therefore ensures that at the time of filing the final operational plan – which may be many years in the future from the date of approval of operation – any new knowledge acquired in the interim period can be duly taken into account.

The licensing procedure under nuclear law stipulates that the “Safety Criteria for the Permanent Storage of Radioactive Waste in a Mine” [3-13] must be taken into account. This was the case in the licensing procedure for the Konrad mine repository. These safety criteria were likewise taken into account when preparing for the licensing procedure for the closure of the Morsleben repository. The safety criteria include provisions regulating closure under point 9 (closure in the sense of the Joint Convention). These provide that voids must be backfilled and sealed with suitable materials, using appropriate techniques, in order to increase stability by means of void reduction. As a general rule, the potential release of radionuclides must be limited to an admissible extent. Consequently, due regard for these guidelines ensures in the field of nuclear legislation that all necessary measures are planned prior to closure but may only be carried out after licensing.

**Konrad Mine Repository**

With respect to German repositories, official plan approval exists for the Konrad mine repository. This also stipulates regulations pertaining to the closure of the repository. The applicant (BfS) filed plans for the closure of both the mine openings and the shafts. Expert evaluation indicates that these plans conform to the current state of the art in science and technology.

So far, no repository in deep geological formations has been either backfilled or closed in the Federal Republic of Germany. Plans in this respect for the Konrad mine as a repository for radioactive waste with negligible heat generation were filed and approved within the scope of the licensing procedure that was concluded in May 2002. Concrete details of the measures required in order to comply with the protection targets following the cessation of emplacement operations have not yet been finalised. Since closure does not generally take place for several decades, such details must be specified according to the state of the art in science and technology existing at that time within the context of separate procedures encompassing the requirements of nuclear legislation, mining and water legislation as well as other legal requirements.

**Morsleben Repository**

The closure of the Morsleben repository is in preparation. During this phase, all relevant information gathered during the operational period 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 minimised 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 Section 9b of the Atomic Energy Act (AtG), any major alterations of the Morsleben repository, i.e. also any measures concerning its closure require a plan approval by the competent environmental ministry of the Land Saxony-Anhalt. In the scope of the licensing procedure for the Morsleben repository, the only difference to the plan approval procedure for Section 7 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 cannot be directed at the requirements for safe closure. The plan approval according to the Atomic Law states that the plan for closure is permissible with respect to all public interests which are touched. The licensing of the operating plans according to mining law lies within the responsibility of the mining authority of Saxony-Anhalt.

The plan approval procedure for operation of the repository which had been initiated in 1992 was restricted to decommissioning (or closure in the sense of the Convention) upon application of the BfS in 1997. The first step in the environmental impact assessment which is required as part of the plan approval procedure was to define the required documents according to section 5 of the Environmental Impact Assessment Act (UVPG). The documents are currently further amended.

In parallel to the environmental impact assessment, other measures for hazard control were carried out on the basis of licences according to mining law. This aimed at the long-term stability of the mine by backfilling cavities in the central part. In the course of these measures, about 10 % of the open cavities of the mine will be filled until 2009. This will not anticipate any measures for closure, in particular as the disposal areas are not backfilled as part of the premature backfilling. It is planned to terminate the plan approval procedure until 2008 and to start the measures for closure afterwards.

The Morsleben repository has been designed and taken into operation at time of the former GDR. A closure concept has been developed in 1989 which included the scheduled flooding of the mine. After takeover as a federal repository in the course of the German reunification, new conclusions from the operational phase and from dedicated geological, geotechnical, geochemical and mining technique assessments for the development of a new closure concept were included. The closure concept intends to hydraulically isolate the disposal areas, i. e. the mine workings used for disposal of radioactive waste and their wider surroundings, from the rest of the mine workings by sealing the drifts with salt concrete. Sealing of drifts pose high demands with respect to their hydraulic and geo-mechanical properties. The access of solutions into the disposal areas and the spread of radionuclides from the disposal areas shall be impeded in the long term. In addition, the entire mine works shall 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 extraction processes at soluble layers of potash salt by water access. The concept for backfilling and sealing further includes the closure of both shafts of the ERAM by systems of sealing elements of various materials with low penetrability in order to minimise the influx of groundwater from the overlying rock into the mine and the discharge of radionuclides in solution from the mine into the overlying rock. The measures within the closure concept aim at stabilizing the mine works and to isolate the radioactive wastes in such a way that the protection targets of the AtG are complied with. The closure concept of the Morsleben repository requires approval by a plan approval procedure.

**Asse Research Mine**

Following the end of mining operation, the former Asse salt mine was concieved not as a repository, but into a research mine. Although it is still used for research purposes (to study a rock salt concrete barrier system that is to serve for isolation and support), it has been removed from supervision under nuclear law and is only subject to mining law supervision.

However, under mining law supervision it is still necessary that a long-term safety case is provided for the closure of a mine. The knowledge gained during mining and research operation has been incorporated in the backfilling plans. The regional *Land* authority in charge of licensing the implementation of the decommissioning and backfilling plans in this case is the Lower Saxon State Mining Authority (*Landesbergamt Niedersachsen*).

The nuclear supervisory authority could become active once again on the basis of Section 19 AtG (state supervision).

**Article 17 (Institutional measures after closure)**

*Article 17*

*Each Contracting Party shall take the appropriate steps to ensure that after closure of a disposal facility:*

*Article 17*

*(i) records of the location, design and inventory of that facility required by the regulatory body are preserved;*

Official plan approval has only been issued for the Konrad repository. This also includes regulations governing the post-operational period following. A collateral clause stipulates that:

> Documentation must be provided during construction, operation and decommissioning of the repository, comprised of data relating to the mine survey of the repository, the characteristics of the wastes deposited (type, quantity, emplacement area, nuclide spectrum, activities), as well as the relevant technical measures. Full sets of documentation must be kept by the operator of the repository at a suitable place and must be duly protected. In addition, the operator must provide full sets of documentation for the atomic authority and for the competent mining office, respectively, which are to be kept under protection in separate locations. The sets of documentation kept by the supervisory authorities must be updated on an annual basis as long as the repository is operational or in the process of decommissioning. For the period following its closure, the form, extent and the storage locations (at least at two separate locations) of the long-term documentation must be specified in the closure plan (*Abschlussbetriebsplan*) and submitted to the supervisory authorities for approval.

The plan approval notice for the Konrad repository is not yet enforceable because it has been challenged before the courts. However, it can be assumed that the aforementioned regulations for the post-operation phase 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.

*Article 17*

*(ii) active or passive institutional controls such as monitoring or access restrictions are carried out, if required;*

So far, there exist no binding regulations. However, it will have to be examined in the plan approval procedures for repositories which kinds of controls have to be carried out after closure.

The type of 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 (*Abschlussbetriebsplan*) and the results added to the long-term documentation.

As such, the required institutional controls are primarily limited to passive measures. Active measures are not envisaged in view of the design of the repository. Should the results from routine surveillance so require, counteractive action may be initiated by means of intervention on the part of the authorities.

The procedure for the Morsleben repository has not yet been specified.

*Article 17*

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

As outlined in the remarks on Article 17 (ii), no special control or surveillance measures are required following the closure of a repository 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 for the Konrad repository stipulate that routine surveillance data must likewise be evaluated in this respect. The closure of the Morsleben repository (ERAM) is currently in the planning phase, and therefore plan approval is not yet available. However, the routine surveillance programme as stipulated in the regulations must also be carried out for this site.

## Section I. Transboundary Movement

### Article 27 (Transboundary movement)

*Article 27*

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.*

Transboundary movements of spent fuel assemblies and radioactive waste are subject to licensing in Germany. Current German legislation requires that the delivering party (i.e. exporter) must submit an application to the competent authority (the Federal Office of Economics and Export Control (BAFA)) for each shipment of these materials. The BAFA must determine whether all legal provisions have been met and if so, grants the licence and subsequently, within the framework of waste management control, monitors compliance with the legal requirements during each individual shipment. In principle, a licence for a given quantity of material may be used for several individual shipments of partial amounts. In the case of shipment of radioactive waste from other EU states to Germany, the licensing authority in the delivering country shall be responsible; however, the BAFA is also consulted.

Transboundary movements of spent fuel assemblies and radioactive waste will only be authorized 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.

*Article 27 1.*

*In so doing:*

*Article 27 1.*

(i) *a Contracting Party which is a State of origin shall take the appropriate steps to ensure that transboundary movement is authorized and takes place only with the prior notification and consent of the State of destination;*

**Spent Fuel assemblies**

Essential for all transboundary movements of spent fuel assemblies to or from the Federal Republic of Germany is a licence according to Section 3 of the German Atomic Energy Act (AtG) [1A-3]; here, the competent authority is the BAFA. Such a licence will only be granted if there are no concerns regarding the applicant's reliability and if compliance with national and international safety regulations is guaranteed.

In the case of shipments out of Germany, it is additionally necessary to ensure that the State of destination will not put the consignment to any use whatsoever in a manner that will endanger Germany's international obligations in the field of nuclear power or its internal or external security (Section 3, para. 3 AtG).

Observance of these additional provisions is checked by the BAFA on the basis of contracts and declarations which must be submitted by the State of destination. Within the context of parallel supervision of a material's movements by EURATOM, to whom monthly reports 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 the shipments to France and Britain, official confirmations from the State of destination were not obtained directly for each individual shipment. Instead, these were issued in advance by an exchange of notes between the Governments of France and Britain with the German Federal Government. This notified the existing reprocessing contracts and the associated shipments as a whole.

As of 1 July 2005, the shipment of spent fuel assemblies for reprocessing will by law no longer be permitted. The final shipment to France took place on 27 April 2005.

In the case of return deliveries e.g. of spent fuel assemblies from research reactors back to the USA, export cannot take place until the BAFA has received an official import certificate from the United States. For other states, an exchange of notes takes place between the affected government prior to the delivery, as part of the licensing procedure under foreign trade law.

**Radioactive Waste**

Each transboundary movement of radioactive waste is subject to the provisions of Directive 92/3/EURATOM [EUR 92]. This Directive was transformed into national law with the Ordinance on the Transboundary Movement of Radioactive Waste (AtAV) [1A-18]. Directive 92/3/EURATOM is currently being amended, i. a. to adapt it to this Article 27. It primarily comprises the following provisions:

**Transboundary movement within the European Community**
The holder of radioactive waste applies to the competent authority in his country (in Germany, this is the BAFA) for a licence. There is a standard form available for this purpose, which is divided into different sections. Section 1 is the application form. The competent authority forwards a copy of this section together with section 2 ("Approval of the consulted competent authority") to this competent authority in the State of destination (which in the case of shipments to Germany is the BAFA). This section 2 is only approved by the BAFA and mailed back to the competent licensing authority provided both the consignee and his competent supervising authority have likewise given their consent to the proposed shipment. Section 3, the licence itself, can then be issued and handed over to the applicant.

During a shipment, all documents must be carried, including section 4 (“loading list“) and 5 ("acknowledgement of receipt"). In the case of transportation by rail, all the aforementioned documents must be transmitted to all affected authorities in advance of each shipment. In order to ensure that all affected authorities are informed about every shipment, and to enable them to log the quantities delivered, they regularly receive copies of the respective sections 4 and 5.

**Transboundary movement to or from states which are not members of the European Community (third countries):**
In the case of shipments from Germany to a third country, the BAFA will only grant a licence to the holder of the radioactive waste provided the competent authority of that third country has confirmed to the BAFA that the consignee holds the necessary licence and the necessary equipment to handle such radioactive waste, and it has been proven that the respective specified criteria for the export of radioactive waste to third countries have been met.

In case of a shipment from a third country to Germany, the consignee is the applicant, and will only receive a licence from the BAFA provided he holds the necessary licence and the necessary equipment to handle such radioactive waste or has notified such handling in accordance with an existing obligation.

*Article 27 1.*

*(ii) transboundary movement through States of transit shall be subject to those international obligations which are relevant to the particular modes of transport utilized;*

In the case of transit through Germany of spent fuel assemblies, which are not radioactive waste and therefore do not fall under the provisions of the AtAV, the BAFA is not involved. Supervision of the transit such spent fuel assemblies is the responsibility of the Federal Office for Radiation Protection (BfS), and in the case of transportation by rail, the Federal Office for Railways (EBA).

In the case of transit of radioactive waste, the BAFA must be consulted under the provisions of Directive 92/3/EURATOM [EUR 92] or of the AtAV; the transit therefore is subject to approval. Such approval will only be granted if there are no facts leading to concerns vis-à-vis proper delivery to the country of destination.

*Article 27 1.*

*(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;*

Transboundary movements of spent fuel assemblies and of radioactive waste will only be licensed by the expert staff at Germany's competent authority, the BAFA, provided the consignee in Germany ensures that such materials conform to the safety measures outlined in the comments on Articles 4 to 17 and 21 to 26. Prior to receiving such material, the consignee must apply to the BAFA for a licence under the statutory provisions outlined in with respect to Article 27 1. (i). The BAFA will verify compliance with these provisions. Under EU law, this procedure does not apply within the Member States of the EU.

*Article 27 1.*

*(iv) a Contracting Party which is a State of origin shall authorize 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;*

In the case of deliveries of spent fuel assemblies out of Germany, a licence will only be granted provided the consignee, according to the documents available, fulfils the provisions outlined under Article 27 1. (iii), i.e. the international and/or European provisions are met and there are no substantiated doubts that this is so. In the case of deliveries of radioactive waste out of Germany, the requirements outlined in Article 27 1. (iii) are met by the consultation process pursuant to the AtAV in conjunction with Directive 92/3/EURATOM [EUR 92] (in this respect, cf. the comments on Article 27 1. (i) and (ii)).

*Article 27 1.*

*(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.*

In accordance with Section 3 of the Atomic Energy Act (AtG), the re-import of spent fuel assemblies into Germany is possible in principle; the provisions in this respect were explained under Article 27 (1) i.

Generally speaking, a shipment of radioactive waste under the AtAV in conjunction with Directive 92/3/EURATOM facilitates the option of return shipment in case the envisaged delivery cannot be completed.

According to Section 7, Paragraph 1, No. 3 of the AtAV, shipment to another EU Member State will only be licensed provided measures are taken to ensure that the radioactive waste will be taken back by the original owner if delivery cannot be completed or the provisions for its shipment cannot be met.

According to Section 8, Paragraph 1, No. 4 of the AtAV, shipment to a third country will likewise only be licensed provided measures are taken to ensure that the radioactive waste will be taken back by the original owner if delivery cannot be completed or the provisions for its shipment cannot be met.

According to Section 9, Paragraph 1, No. 3 of the AtAV, shipment from a third country into Germany will only be licensed provided the domestic consignee of the radioactive waste has reached a binding agreement with the foreign owner of the radioactive waste, with the consent of the competent authority in the third country, that the foreign owner will take back the radioactive waste if the shipment process cannot be completed.

Finally, according to Section 13, Paragraph 1, No. 2 of the AtAV, the BAFA may only give its approval to a shipment from another EU Member State to Germany provided measures have been taken to ensure that the radioactive waste will be taken back by the original owner if delivery cannot be completed or the provisions for its shipment cannot be met.

*Article 27*

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.*

In Germany, shipments to the aforementioned region for the purpose of storage or disposal will not be licensed. 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. Section 5 of the AtAV likewise prohibits shipments into this region.

*Article 27*

3. *Nothing in this Convention prejudices or affects:*

*Article 27 3.*

*(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;*

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 69] and to the Convention of 27 October 1956 on the Canalization of the Moselle [Mosel 57].

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*, GG).

*Article 27 3.*

*(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;*

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.

*Article 27 3.*

*(iii) the right of a Contracting Party to export its spent fuel for reprocessing;*

This right remained unaffected until 30 June 2005. From this date on, the shipment of German spent fuel assemblies for reprocessing is no longer be 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.

*Article 27 3.*

*(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.*

The right referred to in this Article is not impaired by including the Convention in German legislation. On the contrary: in an exchange of notes with the French government and with the British government of 1979 and 1990/1991, respectively, the German government reinforced the rights of both these nations to return the waste and other products arising from the reprocessing of spent German fuel assemblies to Germany.

## Section J. <u>Disused Sealed Sources</u>

### Article 28 (Disused sealed sources)

*Article 28*

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.*

Sealed sources are used in Germany in particular in non-destructive materials testing, at large irradiation facilities, in a number of other industrial branches and in agriculture as well as in research and medicine. High-activity sealed source (HASS) which contain e. g. Co-60, Cs-137, Sr-90 or Ir-192 with activities in the GBq or TBq range are used for sterilisation, for curing tumours, in energy production or materials testing.

### National law

Sealed radioactive materials are defined in Section 3, para. 2, no. 29 b of the Radiation Protection Ordinance (StrlSchV) [1A-8] as radioactive substances which are permanently covered on all sides by an airtight, solid, inactive cover or which are permanently embedded in solid inactive materials in such a way that any escape of radioactivity from handling under normal working conditions is reliably prevented. One of the dimensions must not be smaller than 0.2 cm. Marking is required according to Section 68 StrlSchV.

Furthermore, Section 23, para. 2 of the Atomic Energy Act (AtG) [1A-3] defines large sources as radioactive material whose level of activity per package to be carried or shipped exceeds 1000 TBq.

The handling of radiation sources (as well as of radioactive substances in general) requires a licence in accordance with Section 7 of the StrlSchV. Very small sources not exceeding the exemption levels as laid down in Appendix III, Table 1, columns 2 or 3 of the StrlSchV (Section 8, para. 1 in conjunction with Appendix 1, part B, no. 1 or 2 of the StrlSchV) are exempt from this requirement, as is the use of type-tested devices which may contain radiation sources (Section 8, para. 1 in conjunction with Appendix 1, part B, no. 4 of the StrlSchV).

Note: The provisional ruling outlined in Section 117, paragraph 7 of the StrlSchV referring to type approvals issued prior to 1 August 2001 is also relevant in this context. Such type approvals will remain valid until the deadlines specified in the approval certificate. In such cases, the relevant parts of the StrlSchV of 30 June 1989 shall apply, including those relating to licence-free handling in Section 4, paragraphs 1 and 2 (each in conjunction with Appendix II, nos. 2 or 3 and Appendix II, part B, no. 4). The record-keeping obligations for type-approved devices falling under this regulation are regulated in Section 78, paragraph 1, no. 1 of the StrlSchV of 30 June 1989, which stipulates that its whereabouts must be notified to the competent authority.

Sections 69, 70 and 71 of the StrlSchV regulate the acquisition and disposal of radiation sources. For example, Section 69, para. 1 of the StrlSchV contains the basic requirement that radioactive substances whose handling is subject to a licence under Section 7 of the StrlSchV and other pertinent regulations may only be handed over to persons who are in the possession of the necessary licence. According to Section 69, para. 2 of the StrlSchV, when sealed radioactive substances are handed over to another user for further use, the assignee must be provided with a certificate verifying that the casing is tight and contamination-free. Section 69, paragraphs 3 and 4 of the StrlSchV regulate transport and transfer to the consignee. Administrative fines for offences against the regulations of Section 69 of the StrlSchV are laid down in Section 116 of the StrlSchV. Liability with respect to large sources are regulated in Section 38, para. 4, no. 4 and Section 40, para. 2, no. 3 of the AtG.

According to Section 70, para. 1 of the 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. Section 70, para. 4 of the 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 which may be used without a licence in accordance with Section 8, paragraph 1 in conjunction with Appendix 1, part B, no. 4 of the Radiation Protection Ordinance (StrlSchV) must be returned immediately to the holder of the approval upon completion of use in accordance with Section 27, paragraph 1, no. 5 of the StrlSchV.

Section 71 of the StrlSchV regulates the loss, discovery and acquisition of actual control over radioactive materials. 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 (this includes radiation sources) 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. Likewise, any discovery and acquisition of actual control over such materials must also be reported immediately to the competent nuclear supervisory authority or to the authority responsible for public safety and order.

The requirements relating to the technical qualification of persons who handle radioactive sources are laid down in the Guideline on Technical Qualification in the Field of Radiation Protection [3-40]. The requirements are grouped according to the qualifications necessary for different types of work.

Despite this comprehensive regulatory framework, it is impossible to rule out altogether the possibility of rare cases of radioactive sources being lost and found. Such events are documented in the annual reports of the Federal Office for Radiation Protection (BfS) [BfS 02, BfS 04]. In this way, the general public is kept informed about and sensitised to these types of issues. For example, the report [BfS 04] makes reference to the discovery of two sources (Am-241/Be, 18.5 GBq and 703 GBq) in stainless steel scrap of a recycling company at 26 May 2003. Those sources have been illegally disposed of together with the scrap.

During the last years, extensive additions to the international regulatory framework have been made with respect to sealed sources and especially high-activity sources. Those changes have been transformed into national legislation in Germany by a law [1A-23] which by publication in the Federal Law Gazette from 12 August 2005 has entered into force on 18 August 2005. Germany has thus transformed 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) [EUR 03].

Those parts of the EURATOM Basic Safety Standards [1F-18] pertaining to radioactive sources are translated into national legislation by the StrlSchV. The changes in the German regulatory framework also take account of the recommendations provided in the Code of Conduct on the Safety and Security of Radioactive Sources of the IAEA [IAEA 04] and the new IAEA Guidance on the Import and Export of Radioactive Sources“, IAEA-GOV/2004/62-GC(48)/13 [IAEA 04a], which prescribes i.a. a licence obligation for the import and export of radioactive sources exceeding activity values specified in the Code of Conduct. This is in agreement with the declaration of the G-8 summit and the G-8 action plans of 2003 and 2004 which advise the implementation of IAEA recommendations (e.g. [G-8 03]).

In addition, the relevant results from the Code of Conduct on the Safety and Security of Radioactive Sources [IAEA 01, IAEA 04] which has been adopted by the IAEA General Assembly in September 2000 for the first time and which has been substantially amended in the meantime and the Technical Document on the Categorisation of Radiation Sources [IAEA 03] have likewise been taken into account.

In summary, the law [1A-23] causes amendments to the Atomic Energy Act (AtG), the Radiation Protection Ordinance (StrlSchV), the Ordinance on the Financial Security Pursuant to the Atomic Energy Act (AtDeckV) and the Nuclear Waste Transfer Ordinance (AtAV) with respect to regulations for radioactive sources.

It is against the background of a tense security situation in the world that this law serves to stop uncontrolled proliferation of radioactive substances. A more rigid control of high-activity sealed sources is intended by the installation of a central register at the Federal Office for Radiation Protection (BfS). This contributes much to the aim to prevent any radiation exposure of people, goods or the environment by orphan sources due to inadequate surveillance. Up to now, according to Section 24 para. 1 sentence 1 AtG in connection with Section 19 the responsibility for the surveillance of radioactive sources rested with the Federal States. This responsibility is now transferred to the Federal Government.

A further aim is to minimise the availability of radioactive substances which might be misused for terrorist purposes (“dirty bomb”) as effectively as possible. Centralized regulations in connection with emergency preparedness and interventions as well as execution of campaigns for early detection, securing and disposal of orphan sources have been introduced to harmonize existing decentralized regulations, to increase efficiency and to reduce costs.

The central register at the BfS shall contain the following information for each individual source: unique identification number, source strength, radionuclide and technical characteristics (e. g. the cover), information on the licences for handling and import and if applicable notes on loss, theft or discovery.

The changes to the regulatory framework also provide for the fact that spent high-active sealed sources must always be taken back by the manufacturer, importer or another holder of a licence, who must dispose of the source in an appropriate way or recycle it for re-use. A spent radioactive source means a source which is no longer used or which shall no longer be used.

Further amendments pertain to the Radiation Protection Ordinance (StrlSchV).

As a result from the changes caused by the law [1A-23], a definition for “high-activity sealed sources” is included in Section 3 StrlSchV. Such sources comprise all sealed radioactive substances for which the activity is equal to or greater than the activity values provided in the amended Appendix III table 1 col. 3a, with the exception of fuel assemblies and vitrified high-active fission products from reprocessing of fissile material. Permanently sealed and solid transport or storage containers containing radioactive substances are also no high-activity sources according to this definition. The amendments to Appendix III table 1 StrlSchV translate Annex I of the Council Directive 2003/122/EURATOM. For radionuclides which are not listed there but which are contained in Annex I Table A of the Council Directive 96/29/EURATOM [1F-18], the activity levels are one hundredth of the corresponding $A_1$ value of the IAEA Transport Regulations [IAEA 04b].

A new Appendix XV pertaining to Sections 70, 70a and 71 has been introduced in the StrlSchV which contains the modified Standard Record Sheet for high-activity sealed sources (HASS) according to [EUR 03].

**Measures for the safe handling of sources**

Sealed radiation sources may be particularly hazardous, in particular because they are small and used in mobile equipment. As the radioactive substances are encapsulated in metal, outsiders and persons who deal with metal waste could easily come into contact with them. Orphan sources, in particular HASS, may cause severe health detriment for personnel and members of the general public if being disposed of inappropriately, as those persons usually have no or only little knowledge of the dangers of radioactive sources nor of proper disposal. The term “orphan sources” is used for cases where there is no owner as defined by commercial law and no control or surveillance is exerted over the source. Reasons for a source to become orphan may be forgetting it in a device or installation upon disposal, improper handing over or disposal because of lack of knowledge, theft, or other reasons like death of the owner, liquidation of the firm owning the source etc.

The radiological relevance of disused radioactive sources which are not properly disposed of and which may find their way into scrap or onto landfill sites have been recognised by numerous industrialised countries, specifically those with a significant metal processing industry, including Germany. In Germany, virtually all large scrap-handling locations, metal-processing plants, and increasingly landfill sites and conventional waste treatment facilities as well, are now equipped with monitors in order to be able to localize sources buried in scrap and waste.

In addition to the installation of monitors, which is based on the initiative of private industry, monitoring facilities have also been created at various border crossings in Germany in order to detect as early as possible and prevent the import of radiation sources and other forms of contamination. It has been found that the procedures in the individual *Länder* (Federal States) for the creation of such facilities and in the event of detection of disused radiation sources have not yet been harmonised in full. This situation shall be ameliorated by the translation of Council Directive 2003/122/EURATOM [EUR 03] into national legislation as outlined above.

There is continuation in the downward trend of the number of findings of radioactive sources in scrap, since efforts to prevent the input of such sources amongst scrap-issuing companies have evidently borne fruit. This has been assisted by the rigorous application of private law agreements between scrap suppliers and scrap purchasers, under which the presence of activity levels in excess of background levels constitutes a defect and entitles the purchaser to cancellation of the contract.

In Germany, there have been a number of in-depth investigations into the radiological consequences of radioactivity in scrap, particularly of lost disused radiation sources, but also of NORM residues or contamination with nuclides of anthropogenic origin. In this context, a gradual procedure has been developed for handling an activity alarm, depending on the dose level of the respective scrap consignment. Under this procedure, material may be further processed provided it falls below the lower threshold limit of 0.1 μSv/h; if the upper threshold limit of 5 μSv/h is exceeded, the competent authority must always be consulted, and the load must be secured. For the range between these two limits, an approach must be decided in collaboration with the competent authority. Many metal-processing plants, landfill sites and thermal waste treatment facilities now follow this recommendation.

In addition to these reactive measures upon discovering a radiation source, preventive measures to prevent the loss of disused radiation sources are also highly significant. As outlined in the comments on Article 28 1. and 2., to this end, German radiation protection legislation envisages an extensive set of regulations, which have been further amended by the above-mentioned changes.

Starting with 1 July 2004, the IAEA has been using the additional guideline “Rating for Transport and Radiation Source Events” pertaining to the International Nuclear Event Scale (INES). This guideline comprises all civil events with radioactive sources inside and outside of installations and plants, i.a. theft or loss of sources, incidents at medical applications or at accelerators, increased doses on dosimeters, etc. The criteria for the classification of events are i.a. activity release, the exposure of persons, the number of exposed persons, as well as interference with safety barriers. Guidance for the evaluation of such events is given. This approach would lead to the application of the INES scale not only to events at nuclear installations but also to the much more numerous incidents with radioactive sources of all kinds.

*Article 28*

*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.*

Disused sealed sources may only be returned to Germany as regular radioactive material provided the consignee is the original manufacturer who must meet the provisions outlined (as stipulated in Section 5, Paragraph 2, sentence 4 of the Radioactive Waste Shipment Ordinance (AtAV) [1A-18]), or provided the consignee verifiably subjects it to licensed use for irradiation purposes.

According to Section 20, paragraph 1 of the Radiation Protection Ordinance (StrlSchV), such sources may only be shipped from a third country to Germany without a licence under Section 19, paragraph 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 Sections 6, 7 or 9 of the AtG or according to Section 7, paragraph 1 or Section 11, paragraph 2 of the StrlSchV, and
2. reports the shipment to the competent authority as stipulated in Section 22, paragraph 2 of the StrlSchV 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) 1493/93 [EUR 93] apply. This stipulates the following with regard to sealed sources:

(Article 4)

(1) A holder of sealed sources who intends to carry out a shipment of such sources, or to arrange for such a shipment to be carried out, shall obtain a prior written declaration by the consignee of the radioactive substances to the effect that the consignee has complied, in the Member State of destination, with all applicable provisions implementing Directive 96/29/EURATOM [1F-18] and with national requirements for safe storage, usage or disposal of that class or source of waste.

The declaration shall be made by means of the standard documents set out in Annex I to this Regulation (i.e. Regulation (EURATOM) No. 1493/93).

(2) The declaration referred to in paragraph 1 shall be sent by the consignee to the competent authority of the Member State to which the shipment is to be made. The competent authority shall confirm with its stamp on the document that it has taken note of the declaration and the declaration shall then be sent by the consignee to the holder.

However, this is merely a statement of intent which does not permit any control over shipments that have actually taken place, since the Regulation furthermore stipulates:

(Article 5)

(1) The declaration referred to in Article 4 may refer to more than one shipment, provided that:

- the sealed sources or radioactive waste to which it relates have essentially the same physical and chemical properties,
- the sealed sources or radioactive waste to which it relates do not exceed the levels of activity set out in the declaration and
- the shipments are to be made from the same holder to the same consignee and involve the same competent authorities.

(2) The declaration shall be valid for a period of not more than three years from the date of stamping by the competent authority as referred to in Article 4 (2).

A reporting system for realized 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 rectify 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.

The Code of Conduct on the Safety and Security of Radioactive Sources of the IAEA [IAEA 04] and the associated IAEA Guidance on the Import and Export of Radioactive Sources [IAEA 04a] are intended to bring about a harmonisation of the different international practices in connection with the import and export of radioactive sources for non-IAEA Member States, too.

The regulations have been further specified in a new law [1A-23]. As a result, Section 1 AtAV has been amended to the effect that those high-active sources that are no longer handled or intended for handling (disused high-active sources) are exempted from the scope of application. These sources then have to be taken back by the manufacturer, or they have to be disposed of by a third party possessing a corresponding licence to handle them.

## Section K. Planned Activities to Improve Safety

### Current Developments in Connection with the Site Selection Procedure

In December 2002, shortly before the publication of the first National Report under the Joint Waste Management Convention, the AkEnd submitted its recommendations on a site selection procedure to the BMU to conclude Phase I. At the beginning of Phase II in the 1st quarter of 2003, the BMU went about forming a negotiating group with broad public representation. The aim was to discuss the procedure presented by the AkEnd on a broad societal scale to present on this basis to the *Bundestag* (Lower House of Parliament) a proposal for resolution regarding the criteria and site selection procedure for a repository in accordance with the coalition agreement of 16 October 2002. On 20 June 2003, the negotiation group planned by the BMU had to be disbanded due to differing opinions among the institutions intended to take part concerning the need for a new selection procedure.

Since the autumn of 2003, the BMU has been considering transferring the task of commissioning a repository to an association under public law (implementation of the polluter-pays-principle) whose members would be the companies ("parent companies") and, as the case may be, individual power-plant-operating companies and German subsidiaries of foreign companies as well as their legal successors, being the main originators of the radioactive waste (so-called *Verbandslastmodell,* shifting the burden to the above-mentioned association). The tasks of the association are also to include the execution of the selection procedure. The transferred tasks are to be financed largely through membership fees. Work on the draft bill has not yet been concluded. The BMU envisages the surface exploration of at least three potential sites and the underground exploration of two sites. In line with the Coalition Agreement of 20 October 1998, the nationwide search for a site is also to include other potential host rock formations than salt, e. g. clay/clay stone, although the main emphasis will be on the most favourable overall geological situation. The BMU also plans to consider certain forms of public involvement proposed by the AkEnd in the bill.

Regarding the AkEnd proposals and the further procedure, there is consensus within the Federal Government that a suitable site is to be selected in a procedure that has yet to be specified by the Government, and that Gorleben is to be included. Consultations within the Federal Government as to how the procedure is to be structured in detail and which legal provisions will be necessary have not yet been concluded. Following the conclusion of internal preparations at the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and consultation within the Federal Government, the latter will decide on whether it will introduce a bill on the regulation of a site selection procedure.

### National Waste Management Plan

The BMU is currently in the process of drafting a "national waste management plan" outlining the current status, subsequent procedure and timetable for waste management and disposal. In December 2001, the German Bundestag ordered the BMU to present this "national waste management plan" during the 15th legislative period. In November 2003, a working group set up by the BMU completed a draft report to serve as a working basis for the "national waste management plan". It consists mainly of the following four main chapters:

1. Waste Management Concept
2. Current Status and Prognosis
3. Waste Management Planning
4. Repository Planning

In addition, recommendations are given and the need for action is shown up.

The data base for this report was created by a comprehensive study of the current inventory of the radioactive residues and waste in Germany, prepared by order of the BMU by Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) and Institute for applied Ecology in Darmstadt. So far, the *Länder* have been given the opportunity to examine and comment on the draft working basis within the framework of the Technical Committee on Nuclear Fuel Cycle of the advisory *Länder* Committee for Nuclear Energy. The intention is to involve further stakeholders before the draft is submitted to parliament.

The focus of the next steps is on the preparation of a detailed timetable which is to render the individual partial stages on the way to disposal and their interdependencies transparent and serve as a guide for the further procedure of waste management until disposal.

**EU Standards**

The Federal Government supports the Council of the European Communities' initiative to establish uniform standards also for those facilities falling under the scope of this Convention throughout the extended European Union, with the aim to achieve a high level of safety across the EU. A working group composed of representatives from all Member States should compile possible contents of rules for the determination of common norms within the Community regarding the safety of these facilities. The results of the review processes of this Convention, the relevant IAEA Safety Standards as well as NEA and WENRA reports are considered in this context. By comparing the state of the art in science and technology as presented by these regulations with the current condition in the EU Member States, the harmonisation needs are to be identified which are to be answered by corresponding standardisation in the EU.

**Interim Storage of Spent Fuel Assemblies and Radioactive Waste**

With the ban on the transportation to reprocessing facilities effective since 1 July 2005, interim storage of the spent fuel assemblies until their final disposal has become necessary. In order to avoid transports, decentralised interim storage facilities at the power plant sites are mandatory. Unless these are ready for operation, they will be built during 2005/2006 and are to be operational by the end of 2006. Local interim storage facilities are available to relieve possible bottlenecks prior to the commissioning of some storage facilities. As licences are valid for 40 years, safe storage is ensured for this period.

For the interim storage of operational waste and especially of waste arising from the dismantling of decommissioned nuclear facilities (as a direct result of the nuclear phase-out), storage facilities have also been or will be erected at the places of origin of the waste, ensuring the longer-term safe keeping of the waste in special waste packages.

**Updating of the German Regulations in the Area of Waste Management**

The regulations governing fuel supply and waste management are put more and more in concrete terms by international organisations such as the IAEA, and the state of the art in science and technology is constantly progressing. There is furthermore a trend to include international standards more and more in the respective national regulations. The Federal Government welcomes this development and takes the opportunity to subject the body of German regulations to a review process. Within the framework of the revision of the German regulations, a first step is to comprise the identification and assessment of the differences between the international regulations 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.

**Updating of the Nuclear Regulations**

Overall, the aim of the BMU is to update the general nuclear regulations according to the state of the art in science and technology. Among others, international nuclear regulations, practical experience in connection with the application of the existing German nuclear regulations, and lessons learnt from the safety-related evaluation of events and other operating experience as well as from practical licensing and supervision are all taken into account. Germany is furthermore also involved in the WENRA project, which strives for a harmonisation of the West European nuclear regulations.

The BMU will ensure that those affected will be involved in the process of updating the regulations.

# Section L. Annexes

## (a) List of Spent Fuel Management Facilities

The following Tables list the facilities for spent fuel management:

- Wet storage facilities for spent fuel assemblies and their inventories (Table L-1),
- Central interim storage facilities for spent fuel assemblies (Table L-2),
- Pilot conditioning plant at Gorleben (Table L-3)
- Interim storage facilities for spent fuel assemblies for which licences have been submitted under Section 6 of the Atomic Energy Act (AtG) (Table L-4)

Table L-1: Wet storage facilities for spent fuel assemblies and their inventories (as at: 31 December 2004)

| Reactor, site | Licensed positions | Number of positions available for storage [1] | Of which not yet occupied | Stored quantity [2] [t HM] |
|---|---|---|---|---|
| **Cooling ponds at the reactor:** | | | | |
| Brunsbüttel | 828 | 283 | 74 | 36 |
| Krümmel | 1690 | 847 | 33 | 144 |
| Brokdorf | 768 | 533 | 87 | 241 |
| Stade | 237 | 136 | 84 | 19[3] |
| Unterweser | 615 | 377 | 97 | 151 |
| Grohnde | 768 | 568 | 116 | 246 |
| Emsland | 768 | 569 | 188 | 205 |
| Biblis A | 582 | 388 | 83 | 160 |
| Biblis B | 578 | 385 | 28 | 189 |
| Obrigheim[4] | 1210 | 1113 | 868 | 72 |
| Philippsburg 1[5] | 948 | 356 | 141 | 38 |
| Philippsburg 2 | 716 | 523 | 60 | 250 |
| Neckarwestheim 1[6] | 310 | 133 | 13 | 43 |
| Neckarwestheim 2 | 786 | 465 | 83 | 206 |
| Gundremmingen B | 3219 | 2422 | 278 | 373 |
| Gundremmingen C | 3219 | 2423 | 473 | 339 |
| Isar 1 | 2232 | 1439 | 353 | 189 |
| Isar 2 | 792 | 570 | 113 | 244 |
| Grafenrheinfeld | 715 | 500 | 65 | 234 |
| **Other cooling ponds:** | | | | |
| ZAB Greifswald [7] | 4680 | 4680 | 3404 | 150 |

1) taking into account the positions that must be kept free for unloading of the core and other positions that cannot be used
2) spent and partially spent fuel assemblies
3) free from fuel since April 2005
4) including extension outside the reactor building
5) an additional 169 positions usable in unit 2, 19 of which occupied, 150 vacant
6) an additional 128 positions usable in unit 2, 55 of which occupied, 73 vacant
7) only for fuel assemblies from Rheinsberg and Greifswald

Table L-2: Central storage facilities for spent fuel assemblies and heat-generating radioactive waste (as at: 31 December 2004)

| Site | Types of containers | Licensed quantities | Already stored |
|---|---|---|---|
| Ahaus | CASTOR® Ia, Ib, Ic, IIa, V/19, V/19, Series 06 onwards and V/52 at a total of 370 fuel assembly positions<br>CASTOR® THTR/AVR at a total of 320 storage positions (50 fuel assembly positions)<br>Applied for: CASTOR® MTR 2 | 3960 t HM<br>$2x10^{20}$ Bq | 3 CASTOR® V/52 (27 t HM)<br>3 CASTOR® V/19 (31 t HM)<br>305 CASTOR® THTR/AVR containers<br>(50 fuel assembly positions in total) |
| Gorleben | CASTOR® Ia, Ib, Ic, IIa, V/19, V/52, TN 900/1-21 and CASTOR® HAW 20/28 CG, HAW 20/28, Series No. 16 onwards, and TS 28V at a total of 420 fuel assembly positions | 3800 t HM<br>$2x10^{20}$ Bq | 1 CASTOR® IIa (5 t HM)<br>1 CASTOR® Ic (3 t HM)<br>3 CASTOR® V/19 (31 t HM)<br>51 CASTOR® HAW 20/28 CG with 1428 glass logs<br>1 TS 28 V with 28 glass logs |
| Greifswald (ZLN) | CASTOR® 440/84 at 80 fuel assembly positions | 585 t HM<br>$7.5x10^{18}$ Bq | 4 CASTOR® 440/84 from Rheinsberg (29 t HM)<br>39 CASTOR® 440/84 from Greifswald (378 t HM) |
| Jülich | CASTOR® THTR/AVR<br>(max. 158 containers) | 225 kg nuclear fuel; no activity limit | approx. 250000 AVR fuel assembly spheres in 132 CASTOR® THTR/AVR containers |

Table L-3: Pilot conditioning plant (PKA), Gorleben

| Site | Purpose | Capacity | Status |
|---|---|---|---|
| Gorleben | Originally:<br>Conditioning of spent fuel assemblies from power and research reactors; reloading of HLW glass logs into packages suitable for disposal<br>According to stipulation of 11 June 2001:<br>Use restricted to the repair of defect containers | 35 t HM/a at conditioning | Constructed, but not yet operational. Licensed by 3rd Partial License (TEG) of 18/19 December 2000. Immediate execution has not been applied for. |

Table L-4: Main characteristics of the interim spent fuel storage facilities applied for under Section 6 (AtG), as at: 31 December 2004)

| **Nuclear power plant, *Land* (Federal State)** | **Applicant Date of application** | **Description** | **Mass HM [t]** | **Activity [Bq]** | **Thermal power [MW]** | **Sto-rage posi-tions** | **Period of use [years]** | **Type Dimensions L x W x H wall/roof [m]** | **Container** | **Remarks** |
|---|---|---|---|---|---|---|---|---|---|---|
| Biblis (KWB) Hesse | RWE Power AG 23 December 1999 | Fuel assembly storage facility Biblis | 1400 | $8.5x10^{19}$ | 5.3 | 135 | 40 | WTI concept 92x38x18 0.85/0.55 | CASTOR® V/19 | Licensed on 22/09/2003[1)] |
| | RWE Power AG 30 November 2000 | Temporary stor-age facility at the Biblis site | 300 | $7.6x10^{18}$ | 0.7 | 28 | 5 (8 years had been applied for) | Storage area: 7.50 x 4.00 x 3.75; wall and roof element: 0.40 | CASTOR® V/19 | Licensed on 20/12/2001, complement. licence on 16/04/2003 |
| Brokdorf (KBR) Schleswig-Holst. | E.ON Kernkraft GmbH 20 December 1999 | Interim storage facility at the Brokdorf site | 1000 | $5.5x10^{19}$ | 3.75 | 100 | 40 | STEAG concept 93x27x23 1.20/1.30 | CASTOR® V/19 | Licensed on 28/11/2003[1)] |
| Brunsbüttel (KKB) Schleswig-Holst. | Kernkraftwerk Bruns-büttel GmbH 30 November 1999 | Onsite storage facility Brunsbüttel | 450 | $6x10^{19}$ | 2.0 | 80 | 40 | STEAG concept 88x27x23 1.20/1.30 | CASTOR® V/52 | Licensed on 28/11/2003[1)] |
| | Kernkraftwerk Bruns-büttel GmbH 15 August 2000 | Temporary stor-age facility Bruns-büttel | 140 | $1.6x10^{19}$ | 0.67 | 18 | 6 | Storage area: 7.5 x 4.00 x 3.75; wall and roof element: 0.40 | CASTOR® V/52 | |
| Grafenrheinfeld (KKG) Bavaria | E.ON Kernkraft GmbH 23 February 2000 | Storage facility for fuel assembly containers Grafen-rheinfeld | 800 | $5x10^{19}$ | 3.5 | 88 | 40 | WTI concept 62x38x18 0.85/0.55 | CASTOR® V/19 | Licensed on 12/02/2003[1)] |
| Grohnde (KWG) Lower Saxony | E.ON Kernkraft GmbH 20 December 1999 | Interim storage facility at the Grohnde site | 1000 | $5.5x10^{19}$ | 3.75 | 100 | 40 | STEAG concept 93x27x23 1.20/1.30 | CASTOR® V/19 | Licensed on 12/02/2003[1)] |
| Gundremmingen (KRB) Bavaria | RWE Energie AG (now: RWE Power AG) 25 February 000 | Interim fuel as-sembly storage facility at the NPP Gundremmingen site | 1850 | $2.4x10^{20}$ | 6.0 | 192 | 40 | WTI concept 104x38x18 0.85/0.55 | CASTOR® V/52 | Licensed on 19/12/2003[1)] |

| Nuclear power plant, *Land* (Federal State) | Applicant<br>Date of application | Description | Mass HM<br>[t] | Activity<br>[Bq] | Thermal power<br>[MW] | Sto-rage posi-tions | Period of use<br>[years] | Type<br>Dimensions<br>L x W x H<br>wall/roof<br>[m] | Container | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| Isar (KKI)<br>Bavaria | E.ON Kernkraft GmbH<br>23 February 2000 | Storage facility for fuel assembly containers Isar | 1500 | $1.5 \times 10^{20}$ | 6.0 | 152 | 40<br>(Utilisation period of the storage facility: 80 a) | WTI concept<br>92x38x18<br>0.85/0.55 | CASTOR® V/52<br>CASTOR® V/19 | Licensed on 22/09/2003[1)] |
| Krümmel (KKK)<br>Schleswig-Holstein | Kernkraftwerk Krümmel GmbH<br>30 November 1999 | Onsite interim storage facility Krümmel | 775 | $0.96 \times 10^{20}$ | 3.0 | 80 | 40 | STEAG concept<br>83x27x23<br>1.20/1.30 | CASTOR® V/52 | Licensed on 19/12/2003[1)] |
| | Kernkraftwerk Krümmel GmbH<br>15 August 2000 | Temporary storage facility Krümmel | 120 | $1.5 \times 10^{19}$ | 0.42 | 12 | 6 | Storage area: 7.50 x 4.00 x 3.75; wall and roof element: 0.40 | CASTOR® V/52 | Licensed on 20/06/2003[1)] |
| Emsland (KKE)<br>Lower Saxony | Kernkraftwerke Lippe-Ems GmbH<br>22 December 1998 | Onsite interim storage facility Lingen | 1250 | $6.9 \times 10^{19}$ | 4.7 | 130 | 40 | STEAG concept<br>110x30x20<br>1.20/1.30 | CASTOR® V/19 | Licensed on 06/11/2002[1)] |
| Neckarwestheim (GKN)<br>Baden-Wuerttemberg | Gemeinschaftskernkraftwerk Neckar GmbH<br>20 December 1999 | Interim storage facility at the site of the Neckar community nuclear power plant | 1600 | $8.3 \times 10^{19}$ | 3.5 | 151 | 40 | 2 tunnel tubes 112 and 82 x 12.8 x 17.3 respectively | CASTOR® V/19 | Tunnel tube system<br>Licensed on 22/09/2003[1)] |
| | Gemeinschaftskernkraftwerk Neckar GmbH<br>20 December 1999<br>Specification:<br>22 May 2000 | Onsite temporary storage facility | 250 | $1.5 \times 10^{19}$ | 0.78 | 24 | 5 (8 years had been applied for) | Storage area: 7.50 x 4.00 x 3.75; wall and roof element: 0.30 / 0.40 | CASTOR® V/19 | Licensed on 10/04/2001, complement. licence on 20/12/2002 |

| **Nuclear power plant, *Land* (Federal State)** | **Applicant Date of application** | **Description** | **Mass HM [t]** | **Activity [Bq]** | **Thermal power [MW]** | **Sto-rage posi-tions** | **Period of use [years]** | **Type Dimensions L x W x H wall/roof [m]** | **Container** | **Remarks** |
|---|---|---|---|---|---|---|---|---|---|---|
| Philippsburg (KKP) | EnBW Kraftwerke AG | Interim storage facility at the site of the NPP Philippsburg | 1600 | $1.5x10^{20}$ | 6.0 | 152 | 40 | WTI concept | CASTOR® V/19 | Licensed on 19/12/2003 1) |
| | EnBW Kraftwerke AG 20 December 1999 | Temporary stor-age facility at the site of the NPP Philippsburg | 250 | $2.8x10^{19}$ | 0.79 | 24 | 5 (8 years had been applied for) | Storage area: 7.50 x 4.00 x 3.75; wall and roof element: 0.40 | CASTOR® V/19 CASTOR® V/52 | Licensed on 31/07/2002, complement. licence on 17/02/2003 |
| Unterweser (KKU) Lower Saxony | E.ON Kernkraft GmbH 20 December 1999 | Interim storage facility at the Un-terweser site | 800 | $4.4x10^{19}$ | 3.0 | 80 | 40 | STEAG concept 80x27x23 1.20/1.30 | CASTOR® V/19 | Licensed on 22/09/2003 1) |

1) further procedural steps to follow

Note: For the temporary storage facilities already licensed at the Biblis, Philippsburg and Neckarwestheim sites, some of the licensed values differ from the application values (e.g. period of use, mass, activity, thermal power).

## (b) List of Radioactive Waste Management Facilities

The following Tables list the radioactive waste management facilities.

- Facilities for the conditioning of radioactive waste (Table L-5),
- Interim storage facilities for radioactive waste – central interim storage facilities (Table L-6),
- Interim storage facilities for radioactive waste – interim storage facilities in research institutions (Table L-7),
- Interim storage facilities for radioactive waste – interim storage facilities of the nuclear industry (Table L-8),
- Interim storage facilities for radioactive waste – State collecting facilities (Table L-9)
- Repositories for radioactive waste and planned repositories (projects) in the Federal Republic of Germany (Table L-10).

Table L-5: Facilities for the conditioning of radioactive waste

| Facility name | Operator | Facility description | Facility site |
|---|---|---|---|
| PETRA drying facility | GNS Gesellschaft für Nuklear-Service mbH, Essen<br>Forschungszentrum Jülich (FZJ)<br>Energiewerke Nord, Lubmin | Drying of high-pressure compressed waste in 200-l drums, 280-l drums or 400-l drums | Mobile use in nuclear facilities and stationary use at the GNS Duisburg site;<br>Stationary facility in the decontamination plant of the FZJ<br>Stationary facility in the Zwischenlager Nord (ZLN) |
| Drying facility | AEA Technology QSA GmbH (AEAT), Braunschweig | Drying of drums up to defined residual humidity, | Stationary facility at AEAT |
| FAVORIT mobile drying facility | GNS Gesellschaft für Nuklear-Service mbH | Drying of liquid waste in 200-l drums, 400-l drums and in MOSAIK cast-iron containers | Mobile use in nuclear installations |
| Drying facility for mixed waste and sludges | Hansa Projekt Anlagentechnik GmbH, Hamburg | Drum or small container dryer in variable design for 180-l collapsible drums, 200-l or 400-l drums, small containers | Mobile or stationary use in nuclear installations |
| Mobile facility for the refilling and dehydration of nodular resins | Hansa Projekt Anlagentechnik GmbH, Hamburg | Dehydration of nodular resins in pressed cartridges, 200-l drums or cast-iron containers | Mobile use in nuclear installations |
| Drying facility for drums | Verein für Kernverfahrenstechnik und Analytik Rossendorf e. V. (VKTA) | 2-drum drying facility for the drying of sludges, ion-exchange resins, humid soil<br>Drying time: 10-14 days<br>Volume reduction: max. 60 % | Stationary facility at VKTA |
| Resin drying facility | Verein für Kernverfahrenstechnik und Analytik Rossendorf e. V. (VKTA) | Drying of max. 240 l of spent ion-exchange resin. Volume reduction approx. 50 % | Stationary facility at VKTA |
| FAKIR high-pressure hydraulic press | GNS Gesellschaft für Nuklear-Service mbH<br>Forschungszentrum Jülich<br>Energiewerke Nord, Lubmin | Compacting loose waste with the aid of metal cartridges<br>Waste volume reduction up to Factor 10 | Mobile use in nuclear installations and stationary use at GNS Duisburg site;<br>Stationary facility in the FZJ decontamination facility<br>Stationary facility at the ZLN |

| Facility name | Operator | Facility description | Facility site |
|---|---|---|---|
| SUPERPACK<br>Mobile high-pressure press<br>2000 t | Hansa Projekt<br>Anlagentechnik GmbH (HPA), Hamburg | Processing of 180-l, 200-l or 220-l drums<br>Capacity: max. 20 drums/h | Mobile use in nuclear installations |
| Compacting facility | Forschungszentrum<br>Karlsruhe (FZK) | Low-level radioactive waste<br>Caisson technology with gas protection clothing, max. throughput 3000 $m^3/a$<br>Volume reduction factor 6;<br>Medium-level radioactive waste<br>Remote handling technology with airlock and work cells, manipulators, hydraulic shears, hydraulic press | Stationary facility at the decontamination division (HDB) of FZK<br>Stationary facility at the decontamination division (HDB) of FZK |
| Compacting facility | AEA Technology QSA GmbH (AEAT), Braunschweig | Compaction of 200-l drums and of collapsible drums, pressure $\geq$ 30 MPa<br>Capacity : 5000 – 10000 pressing operations / a | Stationary facility at AEAT |
| In-drum press | Verein für Kernverfahrenstechnik und Analytik<br>Rossendorf e. V. (VKTA) | 30-l to 40-l bags are pressed directly into waste drums. | Stationary facility at VKTA |
| Combustion facilities | Forschungszentrum<br>Jülich GmbH,<br>Forschungszentrum Karlsruhe | Combustion of solid and liquid waste | Stationary facility at the decontamination facility of FZJ<br>Stationary facility at the decontamination division (HDB) of FZK |
| Dismantling/decontamination cabin<br>REBEKA | Forschungszentrum<br>Jülich GmbH, | Decontamination in 2 steel cabins of parts weighing up to 25 t by mechanical means with subsequent dismantling | Stationary facility at the decontamination facility of FZJ |
| Karlsruhe vitrification plant | Forschungszentrum<br>Karlsruhe | Vitrification of approx. 60 $m^3$ high-level radioactive fission product concentrate from the operation of the WAK; currently under construction; commissioning planned for 2006 | Karlsruhe reprocessing plant at FZK |

| Facility name | Operator | Facility description | Facility site |
|---|---|---|---|
| Evaporation and immobilisation facility | Forschungszentrum Karlsruhe | Evaporation of low-level radioactive waste water with subsequent cementation of the residues. Max. throughput 6000 $m^3/a$<br>Volume reduction factor 100 | Stationary facility at the HDB of the FZK |
| Decontamination cell | AEA Technology QSA GmbH (AEAT), Braunschweig | Decontamination of equipment parts (e. g. sandblasting), crushing of equipment parts (e. g. flexing, sawing)<br>Max. weight 1 t/piece | Stationary facility at AEAT |
| Cementing facility | AEA Technology QSA GmbH (AEAT), Braunschweig | Immobilisation of waste water with fixing materials, immobilisation of ion-exchange resins with fixing materials | Stationary facility at AEAT |
| Decontamination tubs for chemical decontamination | Energiewerke Nord, Lubmin | Capacity of first tub 2 x 2.5 $m^3$<br>Capacity of second tub 5 $m^3$ | Stationary facility at the ZAW |
| Evaporation facility | Energiewerke Nord, Lubmin | Processing of radioactive liquid waste<br>Throughput 1 $m^3/h$ | Stationary facility at Zwischenlager Nord (ZLN) |
| Rotary thin-film evaporation facility<br>RDVA | Energiewerke Nord, Lubmin | Processing of radioactive liquid waste<br>Throughput 200-250 l/h<br>Reservoir 7 $m^3$ | Stationary facility in the KGR, special building of units 3 & 4, Lubmin |
| Evaporation facility | Forschungszentrum<br>Jülich GmbH, | Processing of low-active waste water, concentrates and sludges; total volume 825 $m^3$, delivery in tankers | Stationary facility at the decontamination facility of the FZJ |
| Conditioning facility for concentrates (tandem conditioning facility) | Hansa Projekt Anlagentechnik GmbH, Hamburg | Loading capacity: 1 x 200-l drum<br>Evaporation: 3-4l/h<br>Drying temperature.: 150-250 °C | Mobile or stationary use in nuclear installations |
| Metal cutting facility<br>MARS | GNS Gesellschaft für Nuklear-Service mbH | Compression (pressing) and subsequent cutting up of metal parts that can be melted afterwards | Stationary use at the GNS Duisburg site |
| Metal cutting facility<br>MARS | Energiewerke Nord, Lubmin | Compression (pressing) and subsequent cutting up of metal parts that can be melted afterwards | Stationary facility at ZLN |
| Band-saw | Energiewerke Nord, Lubmin | Cutting up of solid waste | Stationary facility at ZLN<br>Stationary facility at ZAW |

| Facility name | Operator | Facility description | Facility site |
|---|---|---|---|
| Vertical longitudinal cut band-saw | Energiewerke Nord,<br>Lubmin | Cutting up of solid waste | Stationary facility at ZAW |
| Hydraulic shears | Energiewerke Nord,<br>Lubmin | Cutting up of solid waste of C and stainless steels (round bars, square bars) | Stationary facility at ZAW |
| Cable stripping machine | Energiewerke Nord,<br>Lubmin | Removal of insulation from cable diameter range: Ø 1.5 mm to 90 mm | Stationary facility at ZAW |
| Plasma cutting facility | Energiewerke Nord,<br>Lubmin | Dismantling of austenitic steels<br>Max. cutting range | Stationary facility at ZAW |
| Thermal dismantling room | Energiewerke Nord,<br>Lubmin | With air extraction and filter device,<br>1 t bridge crane, | Stationary facility at ZAW |
| High-pressure wet blast facility with working cabin | Energiewerke Nord,<br>Lubmin | Working cabin with air extraction and filter system<br>Dismantling/cutting by means of automatic device<br>Decontamination by means of hand-held lance | Stationary facility at ZAW |
| Mobile dry blast facility | Energiewerke Nord,<br>Lubmin | Blasting room 8 $m^2$<br>Height 2.5 m<br>Blasting material steel grit or garnet sand | Mobile facility at ZAW |
| Dismantling installations | Verein für Kernverfahrenstechnik und Analytik<br>Rossendorf e. V. (VKTA) | Plasma cutting facility up to 20 mm<br>Cold and band-saws up to 350 mm Ø<br>Hydraulic shears | Stationary facility at VKTA |
| Dismantling box for aerosol filters | Verein für Kernverfahrenstechnik und Analytik<br>Rossendorf e. V. (VKTA) | In the dismantling box, aerosol filters are dismantled until the parts can be placed in a docked 200-l drum. | Stationary facility at VKTA |
| Ion exchange facility | Verein für Kernverfahrenstechnik und Analytik Rossendorf e.V. (VKTA) | Treatment of radioactive waste water, plant throughput 2 $m^3/h$ | Stationary facility at VKTA |

| Facility name | Operator | Facility description | Facility site |
|---|---|---|---|
| Mobile facility for the extraction, mixing, emplacement in containers and conditioning of bead resins and/or filter aids (MAVAK) | RWE NUKEM GmbH, Alzenau (Bavaria) | Extraction, mixing, emplacement in containers and dewatering of bead resins and/or filter aids from the operation of water purification systems in nuclear facilities, emplacement in MOSAIK containers | Mobile use in nuclear facilities |

Table L-6: 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)<br>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 $5 \times 10^{18}$ Bq | Handling licences according to Section 3 of the StrlSchV *) of 27 October 1983, 13 October 1987 and 13 September 1995 | In operation since October 1984 |
| ABFALLLAGER ESENSHAMM<br>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 $1.85 \times 10^{15}$ Bq | Handling licences according to Section 3 of the StrlSchV*) of 24 June 1981, 29 November 1991 and 6 November 1998 | In operation since autumn 1981 |
| SAMMELSTELLE DER EVU MITTERTEICH<br>Bavaria | Interim storage of waste with negligible heat generation from Bavarian nuclear facilities | 40000 waste packages (200-l, 400-l or cast-iron containers) | Handling licences according to Section 3 of the StrlSchV*) of 7 July 1982 | In operation since July 1987 |
| ZWISCHENLAGER NORD (ZLN)<br>Rubenow/Greifswald Mecklenburg-West Pomerania | Interim storage of operational and decommissioning waste from the nuclear power plants Greifswald and Rheinsberg, including interim storage of dismantled large components | 200000 $m^3$ | Handling licences according to Section 3 of the StrlSchV*) of 20 February 1998 | In operation since March 1998 |
| | | | | |

*) As amended on 13 October 1976 and 30 June 1989, respectively

Table L-7: 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 | Section 7 of the AtG | Buffering of waste |
| Forschungsreaktor Garching | Operational waste from the research reactor | Not determined in the licence | Section 7 of the AtG | Approx. 100 $m^3$ available |
| Forschungszentrum Gees-thacht | Operational waste from the research reactor | Not determined in the licence | Section 3 of the StrlSchV*) | Approx. 154 $m^2$ space for conditioned waste |
| Forschungszentrum Jülich | Waste with negligible heat generation, AVR fuel spheres, activated bulky waste | Not determined in the licence | Sections 6, 9 of the AtG, Section 3 of the StrlSchV*) | Approx. 8140 $m^3$ available |
| Forschungszentrum Karlsruhe | 1. Waste with negligible heat generation,<br>2. Heat-generating waste | 1. 77424 $m^3$ (storage volume)<br>2. 1240 $m^3$ (storage volume) | Section 9 of the AtG | Incl. waste produced by some clients |
| Hahn-Meitner-Institut Berlin | Operational waste from the research centre | 37 $m^3$ | Section 7 of the AtG | |
| Institut für Radiochemie Gar-ching | Operational waste from the research institution | Approx. 22 $m^3$ | Section 9 of the AtG,<br>Section 3 of the StrlSchV*) | |
| VKTA Rossendorf | Operational waste from the research site | 2770 $m^3$ (gross total storage vol-ume) | Section 3 of the StrlSchV*) | Rossendorf interim storage facility (ZLR) |

*) as amended on 13 October 1976 and 30 June 1989, respectively

Table L-8: 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 | Sections 6, 7 AtG, | |
| NUKEM, Hanau | Waste with negligible heat generation, waste from dismantling | 1500 m³ | Section 7 AtG | |
| Siemens, Karlstein<br>Framatome ANP | Waste from dismantling | 3200 m³<br>2200 m³ | Section 9 AtG<br>Section 3 StrlSchV*) | Joint licensees of the interim storage facility |
| Interim storage facility of NCS, Hanau | Conditioned waste with negligible heat generation, operational waste and waste from dismantling<br>1. Siemens,<br>2. NUKEM, GNS et al. | 1. approx. 9000 m³<br>2. approx. 4000 m³ | Section 7 StrlSchV*) | |
| Urenco, Gronau | Operational waste from uranium enrichment | Approx. 40 m³ | Section 7 AtG | |

*) as amended on 13 October 1976 and 30 June 1989, respectively

Table L-9: Interim storage facilities for radioactive waste – State collecting facilities

| Name of facility and site | Kind of waste stored | Capacity according to licence | Licence | Remarks |
|---|---|---|---|---|
| State collecting facility Baden-Wuerttemberg, Karlsruhe | Waste from the medical field, research and industry | No capacity limit stated (capacity HDB: 78276 m³) | Section 9 AtG | State collecting facility at FZK in HDB, operator HDB |
| State collecting facility Bavaria, Mitterteich | Waste from the medical field, research and industry | 10000 packages | Section 3 StrlSchV*) | Approx. 2900 m³ available |
| State collecting facility Berlin, Berlin | Waste from the medical field, research and industry | 445 m³ | Section 3 StrlSchV*) | At the Hahn-Meitner-Institut |
| State collecting facility Hesse, Ebsdorfergrund | Waste from the medical field, research and industry | 400 m³ | Section 6 AtG, Section 3 StrlSchV*) | |
| State collecting facility Mecklenburg-Western Pomerania, Rubenow/Greifswald | Waste from the medical field, research and industry | One 20'-container | Section 3 StrlSchV*) | State collecting facility at ZLN, approx. 33 m³ available |
| State collecting facility Lower Saxony, Jülich | Waste from the medical field, research and industry | Capacity acc. to licence of approx. 300 200-l drums | Section 3 StrlSchV*) | Replaces closed Lower Saxon State collecting facility at Steyerberg |
| State collecting facility Northrhine-Westphalia, Jülich | Waste from the medical field, research and industry | 2430 m³ | Section 3 StrlSchV*), Section 9 AtG | On the site of the *Forschungszentrum Jülich* (Jülich Research Centre) |
| State collecting facility Rhineland-Palatinate, Ellweiler | Waste from the medical field, research and industry | 500 m³ | Section 9 AtG, Section 3 StrlSchV*) | |
| State collecting facility Saarland, Elm-Derlen | Waste from the medical field, research and industry | 50 m³ | Section 3 StrlSchV*) | |
| State collecting facility Saxony, Rossendorf/Dresden | Waste from the medical field, research and industry | 300 m³ | Section 3 StrlSchV*) | At VKTA, also used by Thuringia and Saxony-Anhalt |
| State collecting facility of the four north German coastal Federal State, Geesthacht | Waste from the medical field, research and industry | 68 m² storage area | Section 3 StrlSchV*) | Shared use by Schleswig-Holstein, Hamburg and Bremen, the Lower Saxon contingent has been exhausted for several years already |
| AEA Technology QSA GmbH, Leese | Waste from the medical field, research and industry | 3240 m³ | Section 3 StrlSchV*) | Waste from the closed Steyerberg site of the Lower Saxony State collecting facility, |

*) in the versions dated 13 October 1976 and 30 June 1989, respectively

Table L-10: 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 |
|---|---|---|---|---|
| FORSCHUNGSBERGWERK ASSE<br>Remlingen, Lower Saxony | Research and development work for the disposal of radioactive and radiotoxic waste<br>Not a repository acc. to the definition of Section 9a of the AtG | Between 1967 and 1978 approx. 124500 LAW and approx. 1300 MAW waste packages were emplaced for trial purposes | Licence according to Section 3 of the StrlSchV in the version dated 15 October 1965 | Geological host formation: rock salt |
| BERGWERK ZUR ERKUNDUNG DES SALZSTOCKS GORLEBEN<br>Gorleben, Lower Saxony | Proof of the site's suitability for the disposal of all types of radioactive waste | Federal State | Application according to Section 9b of the AtG in 1977 (plan-approval application) | Geological host formation: rock salt<br>Exploration of the site has been put on hold since 1 October 2000 whilst conceptual and safety-related issues are clarified. |
| ENDLAGER SCHACHT KONRAD<br>Salzgitter, Lower Saxony | Repository for radioactive waste with negligible heat generation | | Application according to Section 9b of the AtG in 1982 (plan-approval application)<br>Official approval of the plan (licence) was granted in May 2002 but is not yet enforceable. | Geological host formation: coral oolite (iron ore)<br>Beneath a water-impermeable barrier from the cretaceous period<br>Commissioning: once the plan approval becomes legally valid after the on-going court proceedings are concluded and following a conversion phase of 4 years. |
| ENDLAGER FÜR RADIOAKTIVE ABFÄLLE MORSLEBEN (ERAM)<br>Saxony-Anhalt | Disposal of low-active and medium-active waste with mainly short-lived radionuclides | Disposal of 36753 $m^3$ 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.<br>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<br>On 28 September 1998 emplacement operations were discontinued.<br>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-11),
- Research reactors with a thermal power of 1 MW or above (Table L-12),
- Research reactors with a thermal power of less than 1 MW (Table L-13),
- Commercial fuel cycle facilities (Table L-14).
- Research and prototype fuel cycle facilities (Table L-15)

In each table the facilities are listed in alphabetical order.

Table L-11: Nuclear power plants including prototype reactors with electrical power generation (as at: 1 August 2005)

| | Name of facility, location | Last operator | Type of facility, electrical output (gross) | First criticality | Final shut-down | Status | Planned final status |
|---|---|---|---|---|---|---|---|
| 1 | VAK Versuchsatom-kraftwerk, Kahl, Bavaria | Versuchsatom-kraftwerk Kahl GmbH | BWR 16 Mwe | 11/1960 | 11/1985 | Dis-mantling | Removal, clearance of the site |
| 2 | MZFR Mehrzweckfor-schungs-reaktor, Karls-ruhe, Baden-Württemberg | Forschungs-zentrum Karlsruhe GmbH | PWR with $D_2O$ 57 MWe | 09/1965 | 05/1984 | Dis-mantling | Removal, clearance of the site |
| 3 | KKR Rheinsberg Rheinsberg, Branden-burg | Energiewerke Nord GmbH | PWR (WWER) 70 MWe | 03/1966 | 06/1990 | Dis-mantling | Clearance of the site |
| 4 | KRB A Gundremmingen A, Gundremmingen, Bavaria | Kernkraftwerk RWE-Bayernwerk GmbH | BWR 250 MWe | 08/1966 | 01/1977 | Dis-mantling | Not yet decided |
| 5 | AVR Atomversuchs-kraftwerk, Jülich, North Rhine-Westphalia | Arbeitsgemein-schaft Versuchsre-aktor GmbH | HTGR 15 MWe | 08/1966 | 12/1988 | Dis-mantling | Removal, clearance of the site |
| 6 | KWL Lingen, Lingen, Lower Saxony | Kernkraftwerk Lingen GmbH | BWR 252 MWe | 01/1968 | 01/1977 | Safe con-tainment | Not yet decided |
| 7 | KWO Obrigheim, Obrig-heim, Baden-Württemberg | Kernkraftwerk Obrigheim GmbH | PWR 357 MWe | 09/1968 | 05/2005 | Application for decom-missioning | Clearance of the site |
| 8 | HDR Heißdampfreaktor, Großwelzheim, Bavaria | Forschungs-zentrum Karlsruhe GmbH | BWR 25 MWe | 10/1969 | 04/1971 | Removed | - |
| 9 | KWW Würgassen, Würgassen, North Rhi-ne-Westphalia | E.ON Kernkraft | BWR 670 MWe | 10/1971 | 08/1994 | Dis-mantling | Clearance of the site |
| 10 | KKN Niederaichbach Niederaichbach, Bavaria | Forschungs-zentrum Karlsruhe GmbH | HWGCR 106 MWe | 12/1972 | 07/1974 | Removed | - |
| 11 | KKS Stade, Stade, Lower Saxony | KKW Stade GmbH | PWR 662 MWe | 01/1972 | 11/2003 | Application for decom-missioning | Clearance of the site |
| 12 | KGR 1 Greifswald 1 Lubmin, Mecklenburg-Western Pomerania | Energiewerke Nord GmbH | PWR (WWER) 440 MWe | 12/1973 | 12/1990 | Dis-mantling | Clearance of the site |
| 13 | KGR 2 Greifswald 2 Lubmin, Mecklenburg-Western Pomerania | Energiewerke Nord GmbH | PWR (WWER) 440 MWe | 12/1974 | 02/1990 | Dis-mantling | Clearance of the site |
| 14 | KGR 3 Greifswald 3 Lubmin, Mecklenburg-Western Pomerania | Energiewerke Nord GmbH | PWR (WWER) 440 MWe | 10/1977 | 02/1990 | Dis-mantling | Clearance of the site |

| | Name of facility, location | Last operator | Type of facility, electrical output (gross) | First criticality | Final shut-down | Status | Planned final status |
|---|---|---|---|---|---|---|---|
| 15 | KNK II Kompakte Natri-umgekühlte Reaktoran-lage, Karlsruhe, Baden-Württemberg | Forschungs-zentrum Karlsruhe GmbH | FBR 21 MWe | 10/1977 | 08/1991 | Dis-mantling | 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 | Dis-mantling | Clearance of the site |
| 17 | THTR-300 Thorium-Hochtemperaturreaktor, Hamm-Uentrop, North Rhine-Westphalia | Hochtemperatur-Kernkraft GmbH | HTGR 308 MWe | 09/1983 | 09/1988 | Safe con-tain-ment | Not yet decided |
| 18 | KMK Mülheim-Kärlich Mülheim-Kärlich, Rhine-land-Palatinate | RWE Power AG | PWR 1302 MWe | 03/1986 | 09/1988 | Dis-mantling | Clearance of the site |
| 19 | KGR 5 Greifswald 5 Lubmin, Mecklenburg-Western Pomerania | Energiewerke Nord GmbH | PWR (WWER) 440 MWe | 03/1989 | 11/1989 | Dis-mantling | Clearance of the site |

Table L-12: Research reactors with a thermal power of 1 MW or above that have been removed or are in the decommissioning phase

| | Name of facility, location | Last operator | Type, thermal. output | First criticality | Final shut-down | Status | Planned final status |
|---|---|---|---|---|---|---|---|
| 1 | FMRB – Braunschweig, Lower Saxony | Physikalisch-Technische Bundesanstalt | Pool 1 MW | 10/1967 | 12/1995 | Dismantling | Removal |
| 2 | FR-2 – Karlsruhe, Baden-Württemberg | Forschungszentrum Karlsruhe GmbH | Tank 44 MW | 03/1961 | 12/1981 | Reactor in safe containment | Removal |
| 3 | FRG-2 – Geesthacht, Schleswig-Holstein | GKSS Forschungszentrum Geesthacht GmbH | Pool 15 MW | 03/1963 | 01/1993 | Shut down | Removal |
| 4 | FRJ-1 MERLIN – Jülich, North Rhine-Westphalia | Forschungszentrum Jülich GmbH | Pool 10 MW | 02/1962 | 03/1985 | Dismantling | Removal |
| 5 | FRM – München, Bavaria | Technische Universität München | Pool 4 MW | 10/1957 | 07/2000 | shut down, fuel assemblies removed | Not yet decided |
| 6 | FRN – Neuherberg, Bavaria | GSF Forschungszentrum für Umwelt u. Gesundheit GmbH | TRIGA 1 MW | 08/1972 | 12/1982 | Safe containment | Not yet decided |
| 7 | Nuklearschiff Otto Hahn, Geesthacht, Schleswig-Holstein | GKSS Forschungszentrum Geesthacht GmbH | PWR, ship propulsion 38 MW | 08/1968 | 03/1979 | Ship’s reactor dismantled | Removal |
| 8 | RFR – Rossendorf, Saxony | VKTA Rossendorf | Tank, WWR 10 MW | 12/1957 | 06/1991 | Dismantling | Removal |

Table L-13: Research reactors with a thermal power of less than 1 MW that have been removed or are in the decommissioning phase (as at: 30 Juni 2005)

| | Name of facility, location | Last operator | Type, thermal output | First criticality | Final shut-down | Status | Planned final status |
|---|---|---|---|---|---|---|---|
| 1 | ADIBKA – Jülich, North Rhine-Westphalia | Forschungszentrum Jülich GmbH | Homog. reactor 0.1 kW | 03/1967 | 10/1972 | Removed | - |
| 2 | AEG Nullenerige-Reaktor – Karlstein, Bavaria | Kraftwerk Union | Tank 0.1 kW | 06/1967 | 01/1973 | Removed | - |
| 3 | ANEX – Geesthacht, Schleswig-Holstein | GKSS Forschungszentrum Geesthacht GmbH | Critical formation, 0.1 kW | 05/1964 | 02/1975 | Removed | - |
| 4 | BER-I – Berlin | Hahn-Meitner-Institut Berlin | Homog. reactor 50 kW | 07/1958 | 12/1972 | Reactor filled in concrete | Not yet decided |
| 5 | FRF-1 – Frankfurt/M. | Johann-Wolfgang-Goethe-Universität Frankfurt/M. | Homog. reactor 10 kW | 01/1958 | 03/1968 | Dismantling | Removal |
| 6 | FRH – Hannover, Lower Saxony | Medizinische Hochschule Hannover | TRIGA 250 kW | 01/1973 | 01/1997 | Dismantling | Not yet decided |
| 7 | HD I – Heidelberg, Baden-Württemberg | Deutsches Krebsforschungszentrum Heidelberg | TRIGA 250 kW | 08/1966 | 03/1977 | Partially removed, Dismantling | Removal, clearance of the site |
| 8 | HD II – Heidelberg, Baden-Württemberg | Deutsches Krebsforschungszentrum Heidelberg | TRIGA 250 kW | 02/1978 | 11/1999 | Dismantling | Removal, clearance of the site |
| 9 | KAHTER, Jülich, North Rhine-Westphalia | Forschungszentrum Jülich GmbH | Critical formation, 0.1 kW | 07/1973 | 02/1984 | Removed | - |
| 10 | KEITER, Jülich, North Rhine-Westphalia | Forschungszentrum Jülich GmbH | Critical formation, 1 W | 06/1971 | 01/1982 | Removed | - |
| 11 | PR-10, AEG Prüfreaktor, Karlstein, Bavaria | Kraftwerk Union | Argonaut 0.18 kW | 01/1961 | 1976 | Removed | - |
| 12 | RAKE, Rossendorf, Saxony | VKTA Rossendorf | Tank 0.01 kW | 10/1969 | 11/1991 | Removed | - |
| 13 | RRR, Rossendorf, Saxony | VKTA Rossendorf | Argonaut 1 kW | 12/1962 | 07/1991 | Removed | - |
| 14 | SAR, Munich, Bavaria | Technische Universität München | Argonaut 1 kW | 06/1959 | 10/1968 | Removed | - |
| 15 | SNEAK, Karlsruhe, Baden-Württemberg | Forschungszentrum Karlsruhe GmbH | Homog. reactor 1 kW | 12/1966 | 11/1985 | Removed | - |

| | Name of facility, location | Last operator | Type, thermal output | First criticality | Final shut-down | Status | Planned final status |
|---|---|---|---|---|---|---|---|
| 16 | STARK, Karlsruhe, Baden-Württemberg | Forschungszentrum Karlsruhe GmbH | Argonaut 0.01 kW | 01/1963 | 03/1976 | Removed | - |
| 17 | SUR Bremen – Bremen | Hochschule Bremen | Homog. reactor < 1 W | 10/1967 | 06/1993 | Removed | - |
| 18 | SUR Darmstadt – Darmstadt, Hesse | Technische Hochschule Darmstadt | Homog. reaktor < 1 W | 09/1963 | 02/1985 | Removed | - |
| 19 | SUR Hamburg – Hamburg | Fachhochschule Hamburg | Homog. reactor < 1 W | 01/1965 | 01/1997 | Removed | - |
| 20 | SUR Karlsruhe – Karlsruhe, Baden-Württemberg | Forschungszentrum Karlsruhe GmbH | Homog. reactor < 1 W | 03/1966 | 09/1996 | Removed | - |
| 21 | SUR München – Munich, Bavaria | Technische Universität München | Homog. Reactor < 1 W | 02/1962 | 08/1981 | Removed | - |
| 22 | SUAK – Karlsruhe, Baden-Württemberg | Forschungszentrum Karlsruhe GmbH | Fast subcrit. formation, < 1 W | | | Removed | - |
| 23 | SUA – Munich, Bavaria | Technische Universität München | Subcrit. formation, < 1 W | | | Removed | - |
| 24 | ZLFR – Zittau, Saxony | Hochschule Zittau/Görlitz | 10 W | 05/1979 | 06/2005 | Dismantling | Clearance of the site, use as a museum |

Table L-14: Commercial fuel cycle facilities that have been removed or are in the decommissioning phase

| | Name of facility, location | Operator | Start of operation | End of operation | Status | Planned final status |
|---|---|---|---|---|---|---|
| 1 | HOBEG Brennelementwerk– Hanau, Hesse | Hobeg GmbH | 1962 | 1988 | Removed | - |
| 2 | NUKEM-A Brennelementwerk– Hanau, Hesse | Nukem GmbH | 1962 | 1988 | Removed | - |
| 3 | Siemens Brennelementwerk Betriebsteil Uran, Hanau, Hesse | Siemens AG | 1969 | 1995 | Removed | - |
| 4 | Siemens Brennelementwerk Betriebsteil MOX, Hanau, Hesse | Siemens AG | 1968 | 1991 | Dismantling | Removal |
| 5 | Siemens Brennelementwerk Betriebsteil Karlstein – Karlstein, Bavaria | Siemens AG | 1966 | 1993 | Continued conventional use | - |
| 6 | WAK Wiederaufarbeitungsanlage Karlsruhe, Karlsruhe, Baden-Württemberg | WAK Betriebsgesellschaft mbH | 1971 | 1990 | Dismantling | Removal |

Table L-15: Removed research and prototype facilities with relevance for the nuclear fuel cycle

| | Name of facility, location | Operator | Begin of operation | Final shutdown | Status | Planned final status |
|---|---|---|---|---|---|---|
| 1 | JUPITER Testanlage Wiederaufarbeitung – Jülich, North Rhine-Westphalia | Forschungszentrum Jülich GmbH | 1976 | 1987 | Removed | - |
| 2 | MILLI Laborextraktionsanlage – Karlsruhe, Baden-Württemberg | Forschungszentrum Karlsruhe GmbH | 1970 | 1989 | Removed | - |
| 3 | PUTE Plutoniumextraktionsanlage – Karlsruhe, Baden-Württemberg | Forschungszentrum Karlsruhe GmbH | 1980 | 1991 | Removed | - |

## (f) References to National Laws, Regulations, Requirements, Guides, etc

These references are listed largely according to the structure and sequence outlined in the "Reactor Safety and Radiation Protection Handbook". As a general rule, they must be taken into account during licensing and supervisory procedures by the regulatory body. The list contains only those regulations that are relevant directly or by approriate application in connection with the treatment of spent fuel assemblies and radioactive waste. This is why there are gaps in the numbering of the references.

1 Regulations

- 1A National nuclear and radiation protection regulations
- 1B Regulations concerning the safety of nuclear installations
- 1C Regulations for the transport of radioactive material and accompanying regulations
- 1D Bilateral agreements in the nuclear field and in the area of radiation protection
- 1E Multilateral agreements on nuclear safety and radiation protection with national implementing regulations
- 1F Law of the European Union

2 General Administrative Regulations

3 Announcements by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the formerly competent ministry, the Federal Ministry for the Interior

4 Recommendations of the RSK

5 Rules of the Nuclear Safety Standards Commission (KTA)

## 1 Regulations

### 1A National Nuclear and Radiation Protection Regulations

| | | |
|---|---|---|
| [1A-1] | Gesetz zur Ergänzung des Grundgesetzes vom 23. Dezember 1959, betreffend §§ 74a Nr. 11, 87c (BGBl. I, S. 813) | |
| [1A-2] | Gesetz zur geordneten Beendigung der Kernenergienutzung zur gewerblichen Erzeugung von Elektrizität vom 22. April 2002 (BGBl. I S. 1351) | p. 11, 13 |
| [1A-3] | Gesetz über die friedliche Verwendung der Kernenergie und den Schutz gegen ihre Gefahren (Atomgesetz - AtG) vom 23. Dezember 1959, Neufassung vom 15. Juli 1985 (BGBl. I, Nr. 41), zuletzt geändert durch Gesetz zur Kontrolle hochradioaktiver Strahlenquellen vom 12. August 2005 (BGBl. I S. 2365) | various citations |
| [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, S. 885, 1226), soweit dabei radioaktive Stoffe, insbesondere Radonfolgeprodukte, anwesend sind:<br>• Verordnung über die Gewährleistung von Atomsicherheit und Strahlenschutz vom 11. Oktober 1984 und Durchführungsbestimmung zur Verordnung über die Gewährleistung von Atomsicherheit und Strahlenschutz vom 11. Oktober 1984 (GBl.(DDR) I 1984, Nr. 30, berichtigt GBl.(DDR) I 1987, Nr. 18)<br>• Anordnung zur Gewährleistung des Strahlenschutzes bei Halden und industriellen Absetzanlagen und bei Verwendung darin abgelagerter Materialien vom 17. November 1990 (GBl.(DDR) I 1990, Nr. 34) | |

| | | |
|---|---|---|
| [1A-5] | Gesetz zum vorsorgenden Schutz der Bevölkerung gegen Strahlenbelastung (Strahlenschutzvorsorgegesetz - StrVG) vom 19. Dezember 1986 (BGBl. I, S. 2610), zuletzt geändert durch die 8. ZuständigkeitsanpassungsVO vom 25. November 2003 (BGBl. I S. 2304, 2308) | p. 49, 82, 86, 90 |
| [1A-8] | Verordnung über den Schutz vor Schäden durch ionisierende Strahlen (Strahlenschutzverordnung - StrlSchV) vom 20. Juli 2001 (BGBl. I 2001, Nr. 38), zuletzt geändert durch Gesetz zur Kontrolle hochradioaktiver Strahlenquellen vom 12. August 2005 (BGBl. I S. 2365) | various citations |
| [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), zuletzt geändert durch Gesetz zur Neuregelung des Rechts des Naturschutzes und der Landschaftspflege und zur Anpassung anderer Rechtsvorschriften vom 25. März 2002 (BGBl. I S. 1193, 1217) | p. 48, 54, 56, 91, 102, 107, 123, 134 |
| [1A-11] | Verordnung über die Deckungsvorsorge nach dem Atomgesetz (Atomrechtliche Deckungsvorsorge-Verordnung - AtDeckV) vom 25. Januar 1977 (BGBl. I 1977, S. 220), zuletzt geändert durch Gesetz zur Kontrolle hochradioaktiver Strahlenquellen vom 12. August 2005 (BGBl. I S. 2365) | p. 48, 54, 98 |
| [1A-12] | Kostenverordnung zum Atomgesetz (AtKostV) vom 17. Dezember 1981 (BGBl. I, S. 1457), zuletzt geändert durch die zweite Verordnung zur Änderung der Kostenverordnung zum Atomgesetz vom 15. Dezember 2004 (BGBl.I 2004, Nr. 69) | |
| [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, S. 562), zuletzt geändert durch VO vom 26. Juli 2004 (BGBl. I 2004, Nr. 33) | p. 48, 99, 101 |
| [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), zuletzt geändert durch VO vom 18. Juni 2002 (BGBl. I 2002, Nr. 36) | p. 49, 61, 67, 80, 115, 116 |
| [1A-18] | Verordnung über die Verbringung radioaktiver Abfälle in das oder aus dem Bundesgebiet (Atomrechtliche Abfallverbringungsverordnung - AtAV) vom 27. Juli 1998 (BGBl. I 1998, Nr. 47), zuletzt geändert durch Gesetz zur Kontrolle hochradioaktiver Strahlenquellen vom 12. August 2005 (BGBl. I S. 2365) | p. 48, 146, 154 |
| [1A-19] | Verordnung für die Überprüfung der Zuverlässigkeit zum Schutz gegen Entwendung oder erhebliche Freisetzung radioaktiver Stoffe nach dem Atomgesetz (Atomrechtliche Zuverlässigkeitsüberprüfungs-Verordnung - AtZüV) vom 1. Juli 1999 (BGBl. I 1999, Nr. 35), zuletzt geändert durch G vom 11. Oktober 2003 (BGBl. I 2003, Nr. 73) | p. 108, 131 |
| [1A-20] | Verordnung zur Abgabe von kaliumiodidhaltigen Arzneimitteln zur Iodblockade der Schilddrüse bei radiologischen Ereignissen (Kaliumiodidverordnung - KIV) vom 5. Juni 2003 | |
| [1A-21] | Abkommen vom 16. Mai 1991 zwischen der Regierung der Bundesrepublik Deutschland und der Regierung der Union der Sozialistischen Sowjetrepubliken über die Beendigung der Tätigkeit der sowjetisch/deutschen Aktiengesellschaft Wismut, Gesetz dazu vom 12. Dezember 1991 (BGBl. II 1991, S. 1138), zuletzt geändert durch Gesetz vom 21. November 1996 (BGBl. I 1996, Nr. 61) | |
| [1A-22] | Verordnung zur Festlegung einer Veränderungssperre zur Sicherung der Standorterkundung für eine Anlage zur Endlagerung radioaktiver Abfälle im Bereich des Salzstocks Gorleben (Gorleben-Veränderungssperren-Verordnung - GorlebenVSpV) vom 25. Juli 2005 (BAnz. Nr. 153a vom 16. August 2005) | p. 49 |

| | | |
|---|---|---|
| [1A-23] | Gesetz zur Kontrolle hochradioaktiver Strahlenquellen vom 12. August 2005 (BGBl. I S. 2365) | p. 151, 152, 155 |

## 1B Regulations Concerning the Safety of Nuclear Installations

| | | |
|---|---|---|
| [1B-1] | Strafgesetzbuch vom 15. Mai 1871 (RGBl. S. 127) in der Fassung der Bekanntmachung vom 10. März 1987 (BGBl. I 1987, S. 945+1160) | p. 62 |
| [1B-2] | Bau- und Raumordnungsgesetz 1998 vom 18. August 1997 (BGBl. I 1997, Nr. 59) | p. 51 |
| [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), mit diversen Verordnungen | p. 51 |
| [1B-5] | Gesetz zur Ordnung des Wasserhaushalts (Wasserhaushaltsgesetz) vom 27. Juli 1957, Neufassung vom 12. November 1996 (BGBl. I 1996, Nr. 58), Neufassung vom 19. August 2002 (BGBl. I 2002, Nr. 59) | p. 51 |
| [1B-6] | Gesetz über Naturschutz und Landschaftspflege (Bundesnaturschutzgesetz) vom 12. März 1987 (BGBl. I 1987, S. 889), Neufassung vom 21. September 1998 (BGBl. I 1998, Nr. 66), Neufassung vom 25. März 2002 (BGBl. I 2002, Nr. 22) | p. 51 |
| [1B-7] | Gesetz über technische Arbeitsmittel (Gerätesicherheitsgesetz) vom 24. Juni 1968, Neufassung vom 23. Oktober 1992, (BGBl. I 1992, Nr. 49) | |
| [1B-8] | Betriebsicherheitsverordnung vom 27. September 2002 (BGBl. I 2002, S. 3777) Hinweis: ersetzt u.a. die Dampfkesselverordnung und die Druckbehälterverordnung | |
| [1B-12] | Gesetz über Betriebsärzte, Sicherheitsingenieure und andere Fachkräfte für Arbeitssicherheit vom 12. Dezember 1973 (BGBl. I 1973, S. 1885) | |
| [1B-13] | Gesetz zur Förderung der Kreislaufwirtschaft und Sicherung der umweltverträglichen Beseitigung von Abfällen (Kreislaufwirtschafts- und Abfallgesetz) vom 27. August 1994 (BGBl. I 1994, Nr. 66); zuletzt geändert durch VO vom 29. Oktober 2001 (BGBl. I 2001, Nr. 55) | p. 51, 99 |
| [1B-14] | Umweltverträglichkeitsprüfungsgesetz (UVPG) vom 12. Februar 1990 (BGBl. I, S. 205), Neufassung vom 5. September 2001 (BGBl. I 2001, Nr. 48), zuletzt geändert durch Gesetz vom 3. Mai 2005 (BGBl. I 2005, Nr. 26) | p. 52, 54, 57, 102, 108, 124, 131 |
| [1B-15] | Bundesberggesetz i. d. F. vom 13. August 1980 (BGBl. I S. 1310), zuletzt geändert durch Gesetz vom 19. Juli 2002 (BGBl. I 2002, Nr. 50) | p. 52, 140 |
| [1B-16] | Umweltinformationsgesetz (UIG) vom 8. Juli 1994 (BGBl. I 1994, Nr. 42), Neugestaltung vom 22. Dezember 2004 (BGBl. I 2004, Nr. 73) | |
| [1B-17] | Verordnung zum Schutz vor gefährlichen Stoffen (Gefahrstoffverordnung - GefStoffV), Neufassung vom 15. November 1999 (BGBl. I 1999, Nr. 52) | |

## 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 (ST-1 1996, Revised) 2000<br>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) | |

[1C-4] Übereinkommen vom 9. Mai 1980 über den internationalen Eisenbahnverkehr (COTIF), Gesetz dazu vom 23. Januar 1985 (BGBl. II 1985, Nr. 5)

[1C-5] Internationale Vorschriften über die Beförderung gefährlicher Güter im Seeverkehr (IMDG-Code) der International Maritime Organisation (IMO), einer Sonderorganisation der UN

[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), letzte Änderung vom 19. Februar 2001 (BAnz. 2001, Nr. 44)

[1C-16] Gesetz über die Beförderung gefährlicher Güter (Gefahrgutbeförderungsgesetz - GGBefG vom 6. August 1975 (BGBl. I 1975, S. 2121), Neufassung vom 29. September 1998 (BGBl. I 1998, Nr. 68), zuletzt geändert durch VO vom 6. August 2002 (BGBl. I 2002, Nr. 57)

[1C-17] Verordnung über die innerstaatliche und grenzüberschreitende Beförderung gefährlicher Güter auf der Straße und mit Eisenbahnen (Gefahrgutverordnung Straße und Eisenbahn - GGVSE) vom 11. Dezember 2001 (BGBl. 2001 I, Nr. 67), Neufassung vom 10. September 2003 (BGBl. I 2003, Nr. 49), Neufassung vom 3. Januar 2005 (BGBl. I 2005, Nr. 2)
Hinweis: ersetzt die GefahrgutVO Straße und die GefahrgutVO Eisenbahn S. 3529)

[1C-18] Verordnung über die Beförderung gefährlicher Güter mit Seeschiffen (Gefahrgutverordnung See – GGVSee) vom 4. März 1998 (BGBl. I 1998, Nr. 13), Neufassung vom 4. November 2003 (BGBl. I 2003, Nr. 56), zuletzt geändert durch Gesetz vom 22. März 2004 (BGBl. I 2004, Nr. 13)

[1C-19] Luftverkehrsgesetz (LuftVG) vom 1. August 1922 (RGBl. I 1922, S. 681), Neufassung vom 27. März 1999 (BGBl. I 1999, Nr. 17), zuletzt geändert durch Gesetz vom 11. Januar 2005 (BGBl. I 2005, Nr. 3)

## 1D Bilateral Agreements in the Nuclear Field and in the Area of Radiation Protection

[1D-1] Abkommen zwischen der Bundesrepublik Deutschland und der Bundesrepublik Österreich über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 23. Dezember 1988; Gesetz dazu vom 20. März 1992 (BGBl. II 1992, Nr. 9); in Kraft seit 1. Oktober 1992 (BGBl. II 1992, Nr. 27) p. 90

[1D-2] Abkommen zwischen der Bundesrepublik Deutschland und dem Königreich Belgien über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 6. November 1980; Gesetz dazu vom 30. November 1982 (BGBl. II 1982, S. 1006); in Kraft seit 1. Mai 1984 (BGBl. II 1984, S. 327) p. 90

[1D-3]). Abkommen zwischen der Bundesrepublik Deutschland und der Schweizerischen Eidgenossenschaft über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 28. November 1984; Gesetz dazu vom 22. Januar 1987 (BGBl. II 1987, S. 74); in Kraft seit 1. Dezember 1988 (BGBl. II 1988, S. 967) p. 90

[1D-4] Abkommen zwischen der Bundesrepublik Deutschland und dem Königreich Dänemark über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 16. Mai 1985; Gesetz dazu vom 17. März 1988 (BGBl. II 1988, S. 286); in Kraft seit 1. August 1988 (BGBl. II 1988, S. 619) p. 90

[1D-5] Abkommen zwischen der Bundesrepublik Deutschland und der Französischen Republik über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 3. Februar 1977; Gesetz dazu vom 14. Januar 1980 (BGBl. II 1980, S. 33); in Kraft seit 1. Dezember 1980 (BGBl. II 1980, S. 1438) p. 90

[1D-6] Abkommen zwischen der Bundesrepublik Deutschland und der Regierung der Republik Ungarn über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 9. Juni 1997; Gesetz dazu vom 7. Juli 1998 (BGBl. II 1998, Nr. 24); in Kraft seit 11. September 1998 (BGBl. II 1999, Nr. 6) p. 90

| | | |
|---|---|---|
| [1D-7] | Abkommen zwischen der Bundesrepublik Deutschland und der Republik Litauen über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 15. März 1994; Gesetz dazu vom 12. Januar 1996 (BGBl. II 1996, Nr. 2); in Kraft seit 1. September 1996 (BGBl. II 1996, Nr. 40) | p. 90 |
| [1D-8] | Abkommen zwischen der Bundesrepublik Deutschland und dem Großherzogtum Luxemburg über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 7. Juli 1981; Gesetz dazu vom 7. Juli 1981 (BGBl. II 1981, S. 445); in Kraft seit 1. Dezember 1981 (BGBl. II 1981, S. 1067) | p. 90 |
| [1D-9] | Abkommen zwischen der Bundesrepublik Deutschland und dem Königreich der Niederlande über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 7. Juni 1988; Gesetz dazu vom 20. März 1992 (BGBl. II 1992, Nr. 9); in Kraft seit 1. März 1997 (BGBl. II 1997, Nr. 12) | p. 90 |
| [1D-10] | Abkommen zwischen der Bundesrepublik Deutschland und der Republik Polen über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 10. April 1997; Gesetz dazu vom 7. Juli 1998 (BGBl. II 1998, Nr. 24); in Kraft seit 1. März 1999 (BGBl. II 1999, Nr.1) | p. 90 |
| [1D-11] | Abkommen zwischen der Bundesrepublik Deutschland und der Russischen Föderation über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 16. Dezember 1992; Gesetz dazu vom 19. Oktober 1994 (BGBl. II 1994, Nr. 52); in Kraft seit 11. Juli 1995 (BGBl. II 1997, Nr. 12) | p. 90 |
| [1D-12] | Vertrag zwischen der Bundesrepublik Deutschland und der Tschechischen Republik über die gegenseitige Hilfeleistung bei Katastrophen und Unglücksfällen vom 19. September 2000; Gesetz hierzu vom 16. August 2002 (BGBl. II 2002, Nr. 31); in Kraft seit dem 1. Januar 2003 (BGBl. II 2003, Nr. 2) | p. 90 |

## 1E Multilateral Agreements on Nuclear Safety and Radiation Protection with National Implementing Regulations

Nuclear Safety and Radiation Protection

[1E-1] Convention on Environmental Inpact Assessment in a Transboundary Context (Espoo-Konvention) vom 25. Februar 1991 und Änderungen vom Februar 2001, in Kraft seit 10. September 1997; Gesetz dazu vom 7. Juni 2001 (BGBl.II 2001, Nr. 22); in Kraft für Deutschland seit 8. August 2002
40 Vertragsparteien (4/2005)

[1E-2] Konvention Übereinkommen über den Zugang zu Informationen, die Öffentlichkeitsbeteiligung an Entscheidungsverfahren und den Zugang zu Gerichten in Umweltangelegenheiten (Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus-Konvention) vom 25. Juni 1998, in Kraft seit 30. Oktober 2001; von Deutschland gezeichnet am 21. Dezember 1998
35Vertragsparteien (4/2005)

[1E-3] Übereinkommen Nr. 115 der Internationalen Arbeitsorganisation über den Schutz der Arbeitnehmer vor ionisierenden Strahlen (Convention Concerning the Protection of Workers against Ionising Radiations), vom 22. Juni 1960, in Kraft seit 17. Juni 1962
Gesetz hierzu vom 23. Juli 1973 (BGBl. II 1973, Nr. 37)
in Kraft für Deutschland seit 26. September 1974 (BGBl. II 1973, Nr. 63)

[1E-4] Ratsbeschluss der Organisation für Wirtschaftliche Zusammenarbeit und Entwicklung (OECD) vom 18. Dezember 1962 über die Annahme von Grundnormen für den Strahlenschutz (OECD-Grundnormen) (Radiation Protection Norms)
Gesetz hierzu vom 29. Juli 1964 (BGBl. II 1964, S. 857)
in Kraft für Deutschland seit 3. Mai 1965
Neufassung vom 25. April 1968 (BGBl. II 1970, Nr. 20)

[1E-5] Übereinkommen über den physischen Schutz von Kernmaterial (Convention on the Physical Protection of Nuclear Material (INFCIRC/274 Rev.1), vom 26. Oktober 1979, in Kraft seit 8. Februar 1987
Gesetz hierzu vom 24. April 1990 (BGBl. II 1990, S. 326), zuletzt geändert durch das Strafrechtsänderungsgesetz vom 27. Juni 1994 (BGBl. I 1994, Nr. 40)
in Kraft für Deutschland seit 6. Oktober 1991 (BGBl. II 1995, Nr. 11)
111 Vertragsparteien (4/2005)

[1E-6] Übereinkommen über die frühzeitige Benachrichtigung bei nuklearen Unfällen (Convention on Early Notification of a Nuclear Accident, INFCIRC/335) vom 26. September 1986 und Übereinkommen über Hilfeleistung bei nuklearen Unfällen oder radiologischen Notfällen (Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (INFCIRC/336) vom 26. September 1986, beide in Kraft seit 27. Oktober 1986
Gesetz zu den beiden IAEA-Übereinkommen vom 16. Mai 1989 (BGBl. II 1989, Nr. 18)
in Kraft für Deutschland seit 15. Oktober 1989 (BGBl. II 1993, Nr. 34)
Benachrichtigungsabkommen: 94 Vertragsparteien (4/2005)
Hilfeleistungsabkommen: 90 Vertragsparteien (4/2005)

[1E-7] Übereinkommen über nukleare Sicherheit (Convention on Nuclear Safety (INFCIRC/449)) vom 17. Juni 1994, in Kraft seit 24. Oktober 1996
Gesetz dazu vom 7. Januar 1997 (BGBl. II 1997, Nr. 2)
in Kraft für Deutschland seit 20. April 1997 (BGBl. II 1997, Nr. 14)
56 Vertragsparteien (4/2005)

[1E-8] Gemeinsames Übereinkommen über die Sicherheit der Behandlung abgebrannter Brennelemente und über die Sicherheit der Behandlung radioaktiver Abfälle - Übereinkommen über nukleare Entsorgung (Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, INFCIRC/546) vom 5. September 1997, in Kraft seit 18. Juni 2001;
Gesetz hierzu vom 13. August 1998 (BGBl. II 1998, Nr. 31), in Kraft für Deutschland seit 18. Juni 2001 (BGBl. II 2001
23 Vertragsparteien (1/01)

[1E-9] Vertrag vom 1. Juli 1968 über die Nichtverbreitung von Kernwaffen - Atomwaffensperrvertrag (Treaty on the Non-Proliferation of Nuclear Weapons, INFCIRC/140) vom 1. Juli 1968, in Kraft seit 5. März 1970
Gesetz dazu vom 4. Juni 1974 (BGBl. II 1974, S. 785)
in Kraft für Deutschland seit 2. Mai 1975 (BGBl. II 1976, S. 552)
Verlängerung des Vertrages auf unbegrenzte Zeit am 11. Mai 1995 (BGBl. II 1995, S. 984)
189 Vertragsparteien (1/2004)

[1E-10] Übereinkommen zwischen dem Königreich Belgien, dem Königreich Dänemark, der Bundesrepublik Deutschland, Irland, der Italienischen Republik, dem Großherzogtum Luxemburg, dem Königreich der Niederlande, der Europäischen Atomgemeinschaft und der Internationalen Atomenergie-Organisation in Ausführung von Artikel III Absätze 1 und 4 des Vertrages vom 1. Juli 1968 über die Nichtverbreitung von Kernwaffen - Verifikationsabkommen (Agreement Between the Kingdom of Belgium, the Kingdom of Denmark, the Federal Republic of Germany, Ireland, the Italian Republic, the Grand Duchy of Luxembourg, the Kingdom of the Netherlands, the European Atomic Energy Community and the International Atomic Energy Agency in Implementation of Article III, (1) and (4) of the Treaty on the Non-Proliferation of Nuclear Weapons, INFCIRC/193-193/Add.5) vom 5. April 1973, in Kraft für alle Vertragsparteien seit 21. Februar 1977, später ergänzt
Gesetz hierzu vom 4. Juni 1974 (BGBl. II 1974, S. 794)
Ausführungsgesetz hierzu vom 7. Januar 1980 (BGBl. I 1980, S. 17), zuletzt geändert durch VO vom 29. Oktober 2001 (BGBl.I 2001, Nr. 55)
Zusatzprotokoll vom 22. September 1998, in Kraft seit dem 30. April 2004
Gesetz zum Zusatzprotokoll vom 22. September 1998 vom 29. Januar 2000 (BGBl. I 2000, Nr. 4)
Ausführungsgesetz zum Verifikationsabkommen und zum Zusatzprotokoll vom 29. Januar 2000 (BGBl. I 2000, Nr. 5)
Hinweis: Nichtkernwaffenstaaten der EURATOM 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 (Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter, INFCIRC/205) vom 29. Dezember 1972, in Kraft seit 30. August 1975
Gesetz hierzu vom 11. Februar 1977 (BGBl.II 1977, S. 165); in Kraft für Deutschland seit 8. Dezember 1977 (BGBl.II 1979, S. 273)
Protokoll vom 7. November 1996 zu diesem Übereinkommen
Gesetz hierzu vom 9. Juli 1998 (BGBl.II 1998, Nr. 25), Berichtigung in (BGBl.I 1998, Nr. 79)
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 Atomhaftungs-Übereinkommen (Convention on Third Party Liability in the Field of Nuclear Energy - Paris Convention) vom 29. Juli 1960, ergänzt durch das Protokoll vom 28. Januar 1964 (BGBl. II 1976, S. 310), und das Protokoll vom 16. November 1982, in Kraft seit 1. April 1968; p. 54
Gesetz hierzu vom 8. Juli 1975 (BGBl. II 1975, S. 957), geändert durch Gesetz vom 9. Juni 1980 (BGBl. II 1980, S. 721)
in Kraft für Deutschland seit 30. September 1975 (BGBl. II 1976, S. 308); Gesetz hierzu vom 21. Mai 1985 (BGBl. II 1985, S. 690); in Kraft für Deutschland seit 7. Oktober 1988 (BGBl. II 1989, S. 144)
15 Vertragsparteien (1/2004)

| | | |
|---|---|---|
| [1E-12] | Zusatzübereinkommen zum Pariser Übereinkommen vom 29. Juli 1960 - Brüsseler Zusatzübereinkommen, (Convention Supplementary to the Paris Convention of 29 July 1960 on Third Party Liability in the Field of Nuclear Energy (Brussels Supplementary Convention) vom 31. Januar 1963, ergänzt durch das Protokoll vom 28. Januar 1964 (BGBl. II 1976, S. 310) und das Protokoll vom 16. November 1982;<br>Gesetz hierzu vom 8. Juli 1975 (BGBl. II 1975, S. 957);<br>in Kraft für Deutschland seit 1. Januar 1976 (BGBl. II 1976, S. 308); Gesetz hierzu vom 21. Mai 1985 (BGBl. II 1985, S. 690)<br>in Kraft für Deutschland seit 1. August 1991 (BGBl. II 1995, S. 657);<br>12 Vertragsparteien (1/2004) | p. 54 |
| [1E-14] | Convention on Supplementary Compensation for Nuclear Damage of 12 September 1997, nicht in Kraft<br>3 Vetragsparteien, 13 Signatarstaaten (1/2004) | |
| [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<br>Gesetz dazu vom 28. Juni 1988 (BGBl. II 1988, S. 598)<br>in Kraft für Deutschland seit 21. September 1988 (BGBl. II 1988, S. 955) | |

## 1F Law of the European Union

Agreements, general

| | | |
|---|---|---|
| [1F-1] | Vertrag vom 25. März 1957 zur Gründung der Europäischen Atomgemeinschaft (**EURATOM**) in der Fassung des Vertrages über die **Europäische Union** vom 7. Februar 1992, geändert durch den Beitrittsvertrag vom 24. Juni 1994 in der Fassung des Beschlusses vom 1. Januar 1995 (BGBl. II 1957, S. 753, 1014, 1678; BGBl. II 1992, S. 1251, 1286; BGBl. II 1993, S. 1947; BGBl. II 1994, S. 2022; ABl. EG 1995, Nr. L1)<br>Der Vertrag ist in seiner ursprünglichen Fassung am 1. Januar 1958 in Kraft getreten (BGBl. 1958 II S. 1), die Neufassung trat am 1. November 1993 in Kraft (BGBl. 1993 II S. 1947), Berichtigung der Übersetzung des EURATOM-Vertrages vom 13. Oktober 1999 (BGBl. II 1999, Nr. 31) | p. 47, 105 |
| [1F-2] | Verifikationsabkommen siehe [1E-10] | |
| [1F-3] | Verordnung (EURATOM) 3227/76 der Kommission vom 19. Oktober 1976 zur Anwendung der Bestimmungen der EURATOM-Sicherungsmaßnahmen (ABl. EG 1976, Nr. L363), geändert durch Verordnung EURATOM 2130/93 der Kommission vom 27. Juli 1993 (ABl. EG 1993, Nr. L191), in Überarbeitung | |
| [1F-4] | Bekanntmachung über die Meldung an die Behörden der Mitgliedsstaaten auf dem Gebiet der Sicherungsmaßnahmen gemäß Artikel 79 Abs. 2 des EURATOM-Vertrages vom 12. August 1991 (BGBl. II 1999,. S. 811) | |
| [1F-7] | Agreement for Co-operation in the Peaceful Uses of Nuclear Energy between EURATOM and the United States of America, signed on March 29, 1996 (ABl. EG 1996, Nr. L120) in Kraft seit 12. April 1996 | |
| [1F-10] | Empfehlung 2000/473/EURATOM der Kommission vom 8. Juni 2000 zur Anwendung des Artikels 36 des EURATOM-Vertrages zur Überwachung des Radioaktivitätsgehaltes der Umwelt zur Ermittlung der Exposition der Gesamtbevölkerung (ABl. EG 2000, Nr. L191) | |
| [1F-11] | Empfehlung 91/4/EURATOM der Kommission vom 6. Dezember 1999 betreffend die Anwendung von Artikel 37 des EURATOM-Vertrages (ABl. EG 1999, Nr. L324) | |

| | | |
|---|---|---|
| [1F-12] | Richtlinie 85/337/EWG des Rates vom 27. Juni 1985 über die Umweltverträglichkeitsprüfung bei bestimmten öffentlichen und privaten Projekten (ABl. EG 1985, Nr. L175), geändert durch die Richtlinie 97/11/EG des Rates vom 3. März 1997 (ABl. EG 1997, Nr. L73)<br>Gesetz hierzu ("Gesetz über die Umweltverträglichkeitsprüfung") vom 12. Februar 1990 (BGBl. I 1990, S. 205), zuletzt geändert durch das 6. Überleitungsgesetz vom 25. September 1990 (BGBl. I 1990, S. 2106) | |
| [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)<br>"UVP-Änderungsrichtlinie", derzeit in der Umsetzung | p. 108 |
| [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)<br>• Gesetz hierzu ("Umweltinformationsgesetz - UIG") vom 8. Juli 1994 (BGBl. I 1994, Nr. 42)<br>• Verordnung über Gebühren für Amtshandlungen der Behörden des Bundes beim Vollzug des Umweltinformationsgesetzes (Umweltinformationsgebührenverordnung) vom 7. Dezember 1994 (BGBl. I 1994, Nr. 88) | |
| [1F-15] | Richtlinie 98/34/EG des Europäischen Parlaments und des Rates vom 22. Juni 1998 über ein Informationsverfahren auf dem Gebiet der Normen und technischen Vorschriften (ABl. EG 1998, Nr. L204) | |
| [1F-16] | Richtlinie 98/37/EG des Europäischen Parlaments und des Rates vom 22. Juni 1998 zur Angleichung der Rechts- und Verwaltungsvorschriften der Mitgliedstaaten für Maschinen (ABl. EG 1998, Nr. L207)<br>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) | |
| [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)<br>• Richtlinie vom 2. Februar 1959 (ABl. EG 1959, Nr. 11),<br>• Richtlinie vom 5. März 1962 (ABl. EG 1962, S. 1633/62),<br>• Richtlinie 66/45/EURATOM (ABl. EG 1966, Nr. 216),<br>• Richtlinie 76/579/EURATOM vom 1. Juni 1976 (ABl. EG 1976, Nr. L187),<br>• Richtlinie 79/343/EURATOM vom 27. März 1977 (ABl. EG 1979, Nr. L83),<br>• Richtlinie 80/836/EURATOM vom 15. Juli 1980 (ABl. EG 1980, Nr. L246),<br>• Richtlinie 84/467/EURATOM vom 3. September 1984 (ABl. EG 1984, Nr. L265),<br>• Neufassung mit Berücksichtigung der ICRP 60 in Richtlinie 96/29/EURATOM vom 13. Mai 1996 (ABl EG 1996, Nr. L159) | p. 47, 74, 75, 79, 80, 100, 151, 152, 154 |
| [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)
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 hochradioaktiver Strahlenquellen und herrenloser Strahlenquellen (ABl.EG 2003, Nr. L346)

Radiological Emergencies

[1F-28] Entscheidung 87/600/EURATOM des Rates vom 14. Dezember 1987 über Gemeinschaftsvereinbarungen für den beschleunigten Informationsaustausch im Fall einer radiologischen Notstandssituation (ABl. EG 1987, Nr. L371)

[1F-29] Richtlinie 89/618/EURATOM des Rates vom 27. November 1989 über die Unterrichtung der Bevölkerung über die bei einer radiologischen Notstandssituation geltenden Verhaltensmaßregeln und zu ergreifenden Gesundheitsschutzmaßnahmen (ABl. EG 1989, Nr. L357) p. 88

- 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),
- Kommissionsverordnung (EURATOM) 944/89 vom 12. April 89 (ABl. EG 1989, Nr. L101),
- Kommissionsverordnung (EURATOM) 770/90 vom 29. März 1990 (ABl. EG 1990, Nr. L83)

[1F-31] Ratsverordnung (EWG) 2219/89 vom 18. Juli 1989 über besondere Bedingungen für die Ausfuhr von Nahrungsmitteln und Futtermitteln im Falle eines nuklearen Unfalls oder einer anderen radiologischen Notstandssituation (ABl. EG 1989, Nr. L211)

[1F-32] Ratsverordnung (EWG) 3955/87 vom 22. Dezember 1987 über die Einfuhrbedingungen für landwirtschaftliche Erzeugnisse mit Ursprung in Drittländern nach dem Unfall im Kernkraftwerk Tschernobyl (ABl. EG 1987, Nr. L371),

- Verordnung (EWG) 1983/88 der Kommission vom 5. Juli 1988 mit 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 – neuer Bezug auf § 47 StrlSchV i. d. F. v. 20. Juli 2001 | p. 49, 79, 109, 134 |
| [2-2] | Allgemeine Verwaltungsvorschrift zu § 40 Abs. 2, § 95 Abs. 3 StrlSchV und § 35 Abs. 2 RöV (AVV Strahlenpass) vom 20. Juli 2004 (BAnz. 2004, Nr. 142a) | p. 49 |
| [2-3] | Allgemeine Verwaltungsvorschrift zur Ausführung des Gesetzes über die Umweltverträglichkeitsprüfung (UVPVwV) vom 18. September 1995 (GMBl. 1995, Nr. 32) | p. 49 |
| [2-4] | Allgemeine Verwaltungsvorschrift zum Integrierten Meß- und Informationssytem nach dem Strahlenschutzvorsorgegesetz (AVV-IMIS) vom 27. September 1995 (BAnz. 1995, Nr. 200a) | p. 49, 82 |

## 3 Announcements by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the Federal Ministry for the Interior (Extract)

| | | |
|---|---|---|
| [3-1] | Sicherheitskriterien für Kernkraftwerke vom 21. Oktober 1977 (BAnz. 1977, Nr. 206) | p. 49, 96, 108 |
| [3-2] | Richtlinie für den Fachkundenachweis von Kernkraftwerkspersonal vom 14. April 1993 (GMBl. 1993, Nr. 20) | p. |
| [3-4] | Richtlinien über die Anforderungen an Sicherheitsspezifikationen für Kernkraftwerke vom 27. April 1976 (GMBl. 1976, S. 199) | |
| [3-5] | Merkpostenaufstellung mit Gliederung für einen Standardsicherheitsbericht für Kernkraftwerke mit Druckwasserreaktor oder Siedewasserreaktor vom 26. Juli 1976 (GMBl. 1976, S. 418) | |
| [3-6] | Richtlinie für den Schutz von Kernkraftwerken gegen Druckwellen aus chemischen Reaktionen durch Auslegung der Kernkraftwerke hinsichtlich ihrer Festigkeit und induzierten Schwingungen sowie durch Sicherheitsabstände vom 13. September 1976 (BAnz. 1976, Nr. 179) | |
| [3-7-1] | Zusammenstellung der in atomrechtlichen Genehmigungs- und Aufsichtsverfahren für Kernkraftwerke zur Prüfung erforderlichen Informationen (ZPI) vom 20. Oktober 1982 (BAnz. 1983, Nr. 6a) | |
| [3-7-2] | Zusammenstellung der zur bauaufsichtlichen Prüfung kerntechnischer Anlagen erforderlichen Unterlagen vom 6. November 1981 (GMBl. 1981, S. 518) | |
| [3-8] | Grundsätze für die Vergabe von Unteraufträgen durch Sachverständige vom 29. Oktober 1981 (GMBl. 1981, S. 517) | |
| [3-9-1] | Grundsätze zur Dokumentation technischer Unterlagen durch Antragsteller/Genehmigungsinhaber bei Errichtung, Betrieb und Stillegung 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, 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, S. 220) (in Überarbeitung) | p. 49, 100, 101, 129, 134, 141 |

| | | |
|---|---|---|
| [3-15] | 1. Rahmenempfehlungen für den Katastrophenschutz in der Umgebung kerntechnischer Anlagen vom 9. August 1999 (GMBl. 1999, Nr. 28/29)<br>2. Radiologische Grundlagen für Entscheidungen über Maßnahmen zum Schutz der Bevölkerung bei unfallbedingten Freisetzungen von Radionukliden vom 9. August 1999 (GMBl. 1999, Nr. 28/29)<br>3. Verwendung von Jodtabletten zur Jodblockade der Schilddrüse bei einem kerntechnischen Unfall, Bekanntmachung des BMU vom 20. Oktober 2004 einer Empfehlung der SSK (BAnz. 2004, Nr. 220) | p. 86, 89, 109 |
| [3-23] | Richtlinie zur Emissions- und Immissionsüberwachung kerntechnischer Anlagen (REI) vom 30. Juni 1993 (GMBl. 1993, Nr. 29), in Überarbeitung | p. 49, 79, 81, 108 |
| [3-23-2] | ergänzt um die Anhänge B und C vom 20. Dezember 1995 (GMBl. 1996, Nr. 9/10), in Überarbeitung | p. 81 |
| [3-24] | Richtlinie über Dichtheitsprüfungen an umschlossenen radioaktiven Stoffen vom 20. Januar und 4. Februar 2004 (GMBl. 2004, Nr. 27) | |
| [3-25] | Grundsätze zur Entsorgungsvorsorge für Kernkraftwerke vom 19. März 1980 (BAnz. 1980, Nr. 58) | |
| [3-27] | Richtlinie über die Gewährleistung der notwendigen Kenntnisse der beim Betrieb von Kernkraftwerken sonst tätigen Personen vom 30. November 2000 (GMBl. 2001, Nr. 8) | p. 69, 70 |
| [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, S. 48), geändert durch GMBl. 1977, S 664) und die REI (GMBl. 1993, Nr. 29) | |
| [3-32] | Änderung der Empfehlungen zur Planung von Notfallschutzmaßnahmen durch Betreiber von Kernkraftwerken vom 18. Oktober 1977 (GMBl. 1977, S. 664) | |
| [3-33] | Leitlinien zur Beurteilung der Auslegung von Kernkraftwerken mit Druckwasserreaktoren gegen Störfälle im Sinne des § 28 Abs. 3 StrlSchV (Störfall-Leitlinien) vom 18. Oktober 1983 (BAnz. 1983, Nr. 245a)<br>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), Neufassung des Kapitels 4 „Berechnung der Strahlenexposition“ vom 29. Juni 1994 (BAnz. 1994, Nr. 222a), in Überarbeitung<br>(zu § 45 StrlSchV: siehe Abteilung 2, Allgemeine Verwaltungsvorschrift) | p. 108, 109 |
| [3-34] | Rahmenrichtlinie über die Gestaltung von Sachverständigengutachten in atomrechtlichen Verwaltungsverfahren vom 15. Dezember 1983 (GMBl. 1984, S. 21) | p. 108 |
| [3-37-1] | Empfehlung über den Regelungsinhalt von Bescheiden bezüglich der Ableitung radioaktiver Stoffe aus Kernkraftwerken mit Leichtwasserreaktor vom 8. August 1984 (GMBl. 1984, S. 327), in Überarbeitung | |
| [3-38] | Richtlinie für Programme zur Erhaltung der Fachkunde des verantwortlichen Schichtpersonals in Kernkraftwerken vom 1. September 1993 (GMBl. 1993, Nr. 36) | |
| [3-39] | Richtlinie für den Inhalt der Fachkundeprüfung des verantwortlichen Schichtpersonals in Kernkraftwerken vom 23. April 1996 (GMBl. 1996, Nr. 26), in Überarbeitung | |
| [3-40] | Richtlinie über die im Strahlenschutz erforderliche Fachkunde (Fachkunderichtlinie Technik nach StrlSchV) vom 21. Juni 2004 (GMBl. 2004, Nr. 40/41) | p. 69, 76, 151 |
| [3-41] | Richtlinie für das Verfahren zur Vorbereitung und Durchführung von Instandhaltungs- und Änderungsarbeiten in Kernkraftwerken vom 1. Juni 1978 (GMBl. 1978, S. 342), in Überarbeitung | |

[3-42] 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)

[3-42-1] Richtlinie für die Ermittlung der Körperdosen bei innerer Strahlenexposition gemäß den §§ 63 und 63a der Strahlenschutzverordnung (Berechnungsgrundlage) vom 13. März 1997 (BAnz. 1997, Nr. 122a), in Überarbeitung

Richtlinie für den Strahlenschutz des Personals bei der Durchführung von Instandhaltungsarbeiten in Kernkraftwerken mit Leichtwasserreaktor

[3-43] Teil I: Die während der Planung der Anlage zu treffende Vorsorge vom 10. Juli 1978 (GMBl. 1978, S. 418), in Überarbeitung

[3-43-1] Teil II: Die Strahlenschutzmaßnahmen während der Inbetriebsetzung und des Betriebs der Anlage vom 4. August 1981 (GMBl. 1981, S. 363), in Überarbeitung

[3-44] Kontrolle der Eigenüberwachung radioaktiver Emissionen aus Kernkraftwerken vom 5. Februar 1996 (GMBl. 1996, Nr. 9/10)

[3-49] Interpretationen zu den Sicherheitskriterien für Kernkraftwerke
Einzelfehlerkonzept - Grundsätze für die Anwendung des Einzelfehlerkriteriums vom 2. März 1984 (GMBl. 1984, S. 208)

[3-50] Interpretationen zu den Sicherheitskriterien für Kernkraftwerke vom 17. Mai 1979 (GMBl. 1979, S. 161);zu Sicherheitskriterium 2.6: Einwirkungen von außen ;zu Sicherheitskriterium 8.5: Wärmeabfuhr aus dem Sicherheitseinschluß

[3-51] Interpretationen zu den Sicherheitskriterien für Kernkraftwerke vom 28. November 1979 (GMBl. 1980, S. 90)
zu Sicherheitskriterium 2.2: Prüfbarkeit
zu Sicherheitskriterium 2.3: Strahlenbelastung in der Umgebung
zu Sicherheitskriterium 2.6: Einwirkungen von außen
zu Sicherheitskriterium 2.7: Brand- und Explosionsschutz
ergänzende Interpretation zu Sicherheitskriterium 4.3: Nachwärmeabfuhr nach Kühlmittelverlusten

[3-52-2] Erläuterungen zu den Meldekriterien für meldepflichtige Ereignisse in Anlagen zur Spaltung von Kernbrennstoffen (Stand 05/04)

- Zusammenstellung der in den Meldekriterien verwendeten Begriffen (Anlagen zur Spaltung von Kernbrennstoffen) (Stand 05/04)
- Meldeformular zur Meldung eines meldepflichtigen Ereignisses (Anlagen zur Spaltung von Kernbrennstoffen) (Stand (04/04)

[3-52-3] Erläuterungen zu den Meldekriterien für meldepflichtige Ereignisse in Anlagen, die nicht der Spaltung von Kernbrennstoffen dienen (Stand 1/97)

- Meldeformular (Anlagen, die nicht der Spaltung von Kernbrennstoffen dienen) (Stand (12/92)

[3-52-4] Meldung eines Befundes bzgl. Kontamination oder Dosisleistung bei der Beförderung von entleerten Brennelement-Behältern, Behältern mit bestrahlten Brennelementen und Behältern mit verglasten hochradioaktiven Spaltproduktlösungen (Stand 8/00)

- Meldeformular (Behälter) (Stand 7/00)

[3-54] Rahmenempfehlung für die Fernüberwachung von Kernkraftwerken vom 6. Oktober 1980 (GMBl. 1980, S 577), in Überarbeitung

[3-54-1] Empfehlung zur Berechnung der Gebühr nach § 5 AtKostV für die Fernüberwachung von Kernkraftwerken (KFÜ) vom 21. Januar 1983 (GMBl. 1983, S. 146)

| | | |
|---|---|---|
| [3-55] | Musterbenutzungsordnung der Landessammelstellen für radioaktive Abfälle in der Bundesrepublik Deutschland vom 17. März 1981 (GMBl. 1981, S. 163) | |
| [3-55-1] | Grundsätzliche Konzeption für den Ausbau der Landessammelstellen für radioaktive Abfälle vom 26. Oktober 1981 (GMBl. 1981, S. 511) | |
| [3-57] | Anforderungen an den Objektsicherungsdienst und an Objektsicherungsbeauftragte in kerntechnischen Anlagen der Sicherungskategorie I vom 8. April 1986 (GMBl. 1986, S. 242) | p. 69 |
| [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) (ohne Wortlaut) | |
| [3-59] | Richtlinie zur Kontrolle radioaktiver Abfälle mit vernachlässigbarer Wärmeentwicklung, die nicht an eine Landessammelstelle abgeliefert werden (Abfallkontrollrichtlinie) vom 16. Januar 1989 (BAnz. 1989, Nr. 63a), letzte Ergänzung vom 14. Januar 1994(BAnz. 1994, Nr. 19) | p. 49, 61, 74, 99 |
| [3-61] | Richtlinie für die Fachkunde von Strahlenschutzbeauftragten in Kernkraftwerken und sonstigen Anlagen zur Spaltung von Kernbrennstoffen vom 10. Dezember 1990 (GMBl. 1991, S. 56) | |
| [3-62] | Richtlinie über Maßnahmen für den Schutz von Anlagen des Kernbrennstoffkreislaufs und sonstigen kerntechnischen Einrichtungen gegen Störmaßnahmen oder sonstige Einwirkungen zugangsberechtigter Einzelpersonen vom 28. Januar 1991 (GMBl. 1991, S. 228) | p. 98, 109 |
| [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) | |
| [3-64] | Anforderungen an das Sicherungspersonal bei Beförderungen von radioaktiven Stoffen vom 4. Juni 1996 (GMBl. 1996, Nr. 29 + 33) | |
| [3-65] | Anforderungen an Lehrgänge zur Vermittlung kerntechnischer Grundlagenkenntnisse für verantwortliches Schichtpersonal in Kernkraftwerken - Anerkennungskriterien vom 10. Oktober 1994 | |
| [3-67] | Richtlinie über Anforderungen an Personendosismeßstellen nach Strahlenschutz- und Röntgenverordnung vom 10. Dezember 2001 (GMBl. 2002, Nr. 6) | |
| [3-69] | Teil I: Meßprogramm für den Normalbetrieb (Routinemeßprogramm) vom 28. Juli 1994 (GMBl. 1994, Nr. 32), in Überarbeitung | p. 82 |
| [3-69-2] | Teil II: Meßprogramm für den Intensivbetrieb (Intensivmeßprogramm) vom 19. Januar 1995 (GMBl. 1995, Nr. 14), in Überarbeitung | p. 82 |
| [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) | |
| [3-72] | Richtlinie über Anforderungen an Inkorporationsmeßstellen vom 30. September 1996 (GMBl. 1996, Nr. 46), in Überarbeitung | |
| [3-73] | Leitfaden zur Stilllegung von Anlagen nach § 7 des Atomgesetzes vom 14. Juni 1996 (BAnz. 1996, Nr. 211a), in Überarbeitung | p. 49, 92, 128 |
| | Leitfäden zur Durchführung von Periodischen Sicherheitsüberprüfungen (PSÜ) für Kernkraftwerke in der Bundesrepublik Deutschland, in Überarbeitung | |
| [3-74-1] | - Grundlagen zur Periodischen Sicherheitsprüfung für Kernkraftwerke<br>- Leitfaden Sicherheitsstatusanalyse<br>- Leitfaden Probabilistische Sicherheitsanalyse<br>Bekanntmachung vom 18. August 1997 (BAnz. 1997, Nr. 232a) | |
| [3-74-2] | - Leitfaden Deterministische Sicherungsanalyse<br>Bekanntmachung vom 25. Juni 1998 (BAnz. 1998, Nr. 153) | |

## 4 Recommendations of the RSK

| | | |
|---|---|---|
| [4-1] | RSK-Leitlinien für Druckwasserreaktoren<br>Ursprungsfassung (3. Ausgabe vom 14. Oktober 1981) mit Änderungen vom 15.11.1996 | |
| [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 01.03.2001 | p. 49, 98, 100, 101, 106, 108, 112, 113, 114, 128 |
| [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 05.12.2002, mit Neuformulierung in Abschnitt 2.7.1 (dritter Spiegelstrich) vom 16.10.2003 | p. 120, 121, 131, 132, 133, 135, 136, 138 |

## 5 Rules of the Nuclear Safety Standards Commission (KTA)

| Rule no.<br>KTA | Title | Most recent edition | Published in *Bundesanzeiger* / Federal Gazette<br>No. dated | Earlier versions | Bestätigung der Weitergültigkeit | Engl. translation |
|---|---|---|---|---|---|---|
| | **1000 Internal KTA procedural regulations** | | | | | |
| | **1100 Terms and definitions** | | - | | - | - |
| | (glossary by KTA-GS) | 1/96 | | 6/91 | | |
| | **1200 General, administration, organization** | | | | | |
| **1201** | Requirements for the operating manual | 6/98 | 172 a 15/09/98 | 2/78; 3/81; 12/85 | | + |
| **1202** | Requirements for the testing manual | 6/84 | 191 a 09/10/84<br>enclosure 51/84 | - | 15.06.99 | + |
| | **1300 Radiological aspects of industrial safety** | | | | | |
| **1301.1** | Radiation protection considerations for plant personnel in the design and operation of nuclear power plants;<br>Part 1: Design | 11/84 | 40 a 27/02/85 | - | 16.11.04 | + |
| **1301.2** | Radiation protection considerations for plant personnel in the design and operation of nuclear power plants;<br>Part 2: Operation | 6/89 | 158 a 24/08/89<br>Addendum<br>118 29/06/91 | 6/82 | 16.11.04 | + |
| | **1400 Quality assurance** | | | | | |
| **1401** | General requirements regarding quality assurance | 6/96 | 216 a 19/11/96 | 2/80; 12/87 | 19.06.01 | + |
| **1404** | Documentation during the construction and operation of nuclear power plants | 6/89 | 158 a 24/08/89 | - | | + |
| **1408.1** | Quality assurance for weld filler materials and weld additives for pressure and activity retaining system in nuclear power plants;<br>Part 1: Suitability testing | 6/85 | 203 a 29/10/85 | - | 19.06.01 | + |
| **1408.2** | Quality assurance for weld filler materials and weld additives for pressure and activity retaining system in nuclear power plants;<br>Part 2: Manufacturing | 6/85 | 203 a 29/10/85<br>Addendum<br>229 10/12/86 | - | 19.06.01 | + |
| **1408.3** | Quality assurance for weld filler materials and weld additives for pressure and activity retaining system in nuclear power plants;<br>Part 3: Processing | 6/85 | 203 a 29/10/85 | - | 19.06.01 | + |
| | **1500 Radiological protection and monitoring** | | | | | |
| **1501** | Stationary system for monitoring area dose rates within nuclear power plants | 6/91 | 7 a 11/01/92 | 10/77 | | - |
| **1502.1** | Monitoring radioactivity in the inner atmosphere of nuclear power plants;<br>Part 1: Nuclear power plants with light water reactors | 6/86 | 162 a 03/09/86<br>Addendum<br>195 15/10/88 | - | 11.06.96 | + |

| Rule no. KTA | Title | Most recent edition | Published in *Bundesanzeiger* / Federal Gazette No. dated | Earlier versions | Bestätigung der Weitergültigkeit | Engl. translation |
|---|---|---|---|---|---|---|
| (1502.2) | Monitoring radioactivity in the inner atmosphere of nuclear power plants; Part 2: Nuclear power plants with high temperature reactor | 6/89 | 229 a 07/12/89 | - | - | + |
| **1503.1** | Monitoring and assessing the discharge of gaseous and aerosol-bound radioactive substances; Part 1: Monitoring and assessing the stack discharge of radioactive substances during specified normal operation | 6/93 | 211 a 09/11/93 | 2/79 | - | - |
| **1503.2** | Monitoring and assessing the discharge of gaseous and aerosol-bound radioactive substances; Part 2: Monitoring and assessing the stack discharge of radioactive substances during anticipated operational occurrences and accident conditions | 6/99 | 243 b 23/12/99 | - | 16.11.04 | - |
| **1503.3** | Monitoring and assessing the discharge of gaseous and aerosol-bound radioactive substances; Part 3: Monitoring and assessing radioactive substances not discharged via the stack | 6/99 | 243 b 23/12/99 | - | 16.11.04 | - |
| **1504** | Monitoring and assessing the discharge of radioactive substances in liquid effluents | 6/94 | 238 a 20/12/94<br>Addendum<br>216 a 19/11/96 | 6/78 | 15.06.99 | - |
| **1506** | Measuring local dose rates in exclusion areas of nuclear power plants<br>(this rule was withdrawn on 16/11/04) | 6/86 | 162 a 03/09/86<br>Addendum<br>229 10/12/86 | - | 11.06.96 | + |
| **1507** | Monitoring and assessing the discharges of radioactive substances from research reactors | 6/98 | 172 a 15/09/98 | 3/84 | 11.11.03 | - |
| **1508** | Instrumentation to determine atmospheric diffusion of radioactive substances | 9/88 | 37 a 22/02/89 | - | 20.06.00 | + |
| | **2100 Plant** | | | | | |
| **2101.1** | Fire protection in nuclear power plants; Part 1: Basic principles | 12/85 | 33 a 18/02/86 | - | - | + |
| **2103** | Explosion protection in nuclear power plants with light water reactors (general and case-related requirements) | 6/89 | 229 a 07/12/89 | - | | + |
| | **2200 External events** | | | | | |
| **2201.1** | Design of nuclear power plants against seismic events; Part 1: Principles | 6/90 | 20 a 30/01/91 | 6/75 | 20.06.00 | + |
| **2201.2** | Design of nuclear power plants against seismic events; Part 2: Subsurface materials (soil and rock) | 6/90 | 20 a 30/01/91 | 11/82 | 20.06.00 | + |
| **2201.4** | Design of nuclear power plants against seismic events; Part 4: Requirements for procedures for verifying the safety of mechanical and electrical components against earthquakes | 6/90 | 20 a 30/01/91<br>Addendum<br>115 25/06/96 | - | 20.06.00 | + |

| Rule no.<br>KTA | Title | Most recent edition | Published in *Bundesanzeiger* / Federal Gazette<br>No. dated | Earlier versions | Bestäti-gung der Weiter-gültigkeit | Engl. trans-lation |
|---|---|---|---|---|---|---|
| **2201.5** | Design of nuclear power plants against seismic events; Part 5: Seismic instrumentation | 6/96 | 216 a 19/11/96 | 6/77; 6/90 | 19.06.01 | + |
| **2201.6** | Design of nuclear power plants against seismic events; Part 6: Post-seismic measures | 6/92 | 36 a 23/02/93 | - | 18.06.02 | + |
| **2206** | Design of nuclear power plants against lightning effects | 6/00 | 159 a 24/08/00 | 6/92 | - | - |
| **2207** | Flood protection for nuclear power plants | 6/92 | 36 a 23/02/93 | 6/82 | - | + |
| | **2500 Civil engineering** | | | | | |
| **2501** | Waterproofing of structures of nuclear power plants | 9/88 | 37 a 22/02/89 | - | 14.06.94 | + |
| **2502** | Mechanical design of fuel storage pools in nuclear power plants with light water reactors | 6/90 | 20 a 30/01/91 | - | 16.11.04 | + |
| | **3000 Systems in general** | | | | | |
| | **3100 Reactor core and reactor control** | | | | | |
| **3101.1** | Design of reactor cores of pressurized water and boiling water reactors; Part 1 Principles of thermohydraulic design | 2/80 | 92 20/05/80 | - | 20.06.00 | + |
| **3101.2** | Design of reactor cores of pressurized water and boiling water reactors; Part 2: Neutron-physical requirements for design and operation of the reactor core and adjacent systems | 12/87 | 44 a 04/03/88 | - | 10.06.97 | + |
| (3102.1) | Design of reactor cores of high temperature gas-cooled reactors; Part 1: Calculation of the material properties of helium | 6/78 | 189 a 06/10/78<br>Enclosure 23/78 | - | 15.06.93 | + |
| (3102.2) | Reactor core design for high temperature gas-cooled reactors; Part 2: Heat transfer in spherical fuel assemblies | 6/83 | 194 14/10/83<br>Enclosure 47/83 | - | 15.06.93 | + |
| (3102.3) | Reactor core design for high temperature gas-cooled reactors; Part 3: Loss of pressure through friction in pebble bed cores | 3/81 | 136 a 28/07/81<br>Enclosure 24/81 | - | 15.06.93 | + |
| (3102.4) | Reactor core design for high temperature gas-cooled reactors; Part 4: Thermohydraulic analytical model for stationary and quasi-stationary conditions in pebble bed cores | 11/84 | 40 a 27/02/85<br>Addendum<br>124 07/07/89 | - | 15.06.93 | + |
| **3103** | Shutdown systems of light water reactors | 3/84 | 145 a 04/08/84<br>Enclosure 39/84 | - | 15.06.99 | + |
| **3104** | Determination of the shutdown reactivity | 10/79 | 19 a 29/01/80<br>Enclosure 1/80 | - | 16.11.04 | + |
| | **3200 Primary and secondary circuits** | | | | | |
| **3201.1** | Components of the reactor coolant pressure boundary of light water reactors;<br>Part 1: Materials and product forms | 6/98 | 170 a 11/09/98 | 2/79; 11/82; 6/90 | 11.11.03 | + |

| Rule no. KTA | Title | Most recent edition | Published in *Bundesanzeiger* / Federal Gazette No. dated | Earlier versions | Bestätigung der Weitergültigkeit | Engl. translation |
|---|---|---|---|---|---|---|
| **3201.2** | Components of the reactor coolant pressure boundary of light water reactors; Part 2: Design and analysis | 6/96 | 216 a 19/11/96 | 10/80; 3/84 | - | + |
| **3201.3** | Components of the reactor coolant pressure boundary of light water reactors; Part 3: Manufacture | 6/98 | 219 a 20/11/98 | 10/79; 12/87 | - | + |
| **3201.4** | Components of the reactor coolant pressure boundary of light water reactors; Part 4: In-service inspections and operational monitoring | 6/99 | 200 a 22/10/99 | 6/82; 6/90 | - | - |
| **3203** | Monitoring radiation embrittlement of materials of the reactor pressure vessel of light water reactors | 3/84 | 119 a 29/06/84 Enclosure 33/84 | - | - | + |
| **3204** | Reactor pressure vessel internals | 6/98 | 236 a 15/12/98 | 3/84 | - | - |
| **3205.1** | Component support structures with non-integral connections;<br>Part 1: Component support structures with non-integral connections for components of the reactor coolant pressure boundary | 6/91 | 118 a 30/06/92 Addendum 111 17/06/94 | 6/82 | - | + |
| **3205.2** | Component support structures with non-integral connections; Part 2: Component support structures with non-integral connections for pressure and activity-retaining components in systems outside the primary circuit | 6/90 | 41 a 28/02/91 | - | 20.06.00 | + |
| **3205.3** | Component support structures with non-integral connections; Part 3: Series-production standard supports | 6/89 | 229 a 07/12/89 Addendum 111 17/06/94 | - | 15.06.99 | + |
| **3211.1** | Pressure and activity-retaining components of systems outside the reactor coolant pressure boundary; Part 1: Materials | 6/00 | 194 a 14/10/00 | 6/91 | - | - |
| **3211.2** | Pressure and activity-retaining components of systems outside the reactor coolant pressure boundary; Part 2: Design and analysis | 6/92 | 165 a 03/09/93 Addendum 111 17/06/94 | - | - | + |
| **3211.3** | Pressure and activity-retaining components of systems outside the reactor coolant pressure boundary; Part 3: Manufacture | 6/90 | 41 a 28/02/91 | - | - | - |
| **3211.4** | Pressure and activity-retaining components of systems outside the reactor coolant pressure boundary; Part 4: In-service inspections and operational monitoring | 6/96 | 216 a 19/11/96 | - | 19.06.01 | - |
| | **3300 Heat removal** | | | | | |
| **3301** | Residual heat removal systems of light water reactors 2) | 11/84 | 40 a 27/02/85 | - | 14.06.94 | + |
| **3303** | Heat removal systems for fuel assembly storage pools in nuclear power plants with light water reactors | 6/90 | 41 a 28/02/91 | - | 20.06.00 | + |

| Rule no. KTA | Title | Most recent edition | Published in *Bundesanzeiger* / Federal Gazette No. dated | Earlier versions | Bestätigung der Weitergültigkeit | Engl. translation |
|---|---|---|---|---|---|---|
| | **3400 Containment** | | | | | |
| **3401.1** | Steel containment vessels; Part 1: Materials and product forms | 9/88 | 37 a 22/02/89 | 6/80; 11/82 | 16.06.98 | - |
| **3401.2** | Steel containment vessels; Part 2: Analysis and design | 6/85 | 203 a 29/10/85 | 6/80 | 20.06.00 | + |
| **3401.3** | Steel containment vessels; Part 3: Manufacture | 11/86 | 44 a 05/03/87 | 10/79 | 10.06.97 | + |
| **3401.4** | Steel containment vessels; Part 4: In-service inspections | 6/91 | 7 a 11/01/92 | 3/81 | 19.06.01 | - |
| **3402** | Air locks through the containment vessel of nuclear power plants – Personnel locks | 11/76 | 38 24/02/77 | - | 16.11.04 | + |
| **3403** | Cable penetrations through the reactor containment vessel | 10/80 | 44 a 05/03/81 Enclosure 6/81 | 11/76 | 19.06.01 | + |
| **3404** | Isolation of operating system pipes penetrating the containment vessel in the case of a release of radioactive substances into the containment vessel | 9/88 | 37 a 22/02/89 Addendum 119 30/06/90 | | 11.11.03 | + |
| **3405** | Integral leakage rate testing of the containment vessel with the absolute pressure method | 2/79 | 133 a 20/07/79 Enclosure 27/79 | - | 15.06.99 | + |
| **3407** | Pipe penetrations through the reactor containment vessel | 6/91 | 113 a 23/06/92 | - | 19.06.01 | + |
| **3409** | Air-locks for the reactor containment vessel for nuclear power plants – Material locks | 6/79 | 137 26/07/79 | - | 16.11.04 | + |
| **3413** | Determination of loads for the design of a full pressure containment vessel against plant-internal incidents | 6/89 | 229 a 07/12/89 | - | 16.11.04 | + |
| | **3500 Instrumentations and reactor protection** | | | | | |
| **3501** | Reactor protection system and monitoring equipment of the safety system | 6/85 | 203 a 29/10/85 | 3/77 | 20.06.00 | + |
| **3502** | Accident overview measuring systems | 6/99 | 243 b 23/12/99 | 11/82; 11/84 | 16.11.04 | - |
| **3503** | Type testing of electrical modules for the reactor protection system | 11/86 | 93 a 20/05/87 | 6/82 | 10.06.97 | + |
| **3504** | Electrical drives of the safety system in nuclear power plants | 9/88 | 37 a 22/02/89 | - | 16.06.98 | - |
| **3505** | Type testing of measuring transmitters and transducers of the reactor protection system | 11/84 | 40 a 27/02/85 | - | 10.06.97 | + |
| **3506** | Tests and inspections of the instrumentation and control equipment of the safety system of nuclear power plants | 11/84 | 40 a 27/02/85 | - | 18.06.02 | + |
| **3507** | Factory tests, post-repair tests and demonstration of successful service for the instrumentation and control equipment of the safety system | 11/86 | 44 a 05/03/87 | - | - | + |

| Rule no. KTA | Title | Most recent edition | Published in *Bundesanzeiger* / Federal Gazette No. dated | Earlier versions | Bestätigung der Weitergültigkeit | Engl. translation |
|---|---|---|---|---|---|---|
| | **<u>3600 Activity control and activity management</u>** | | | | | |
| **3601** | Ventilation and air filtration systems in nuclear power plants | 6/90 | 41 a 28/02/91 | - | 13.06.95 1) | - |
| **3602** | Storage and handling of nuclear fuel assemblies, control rods and neutron sources in nuclear power plants with light water reactors | 6/90 | 41 a 28/02/91 | 6/82; 6/84 | | - |
| **3603** | Facilities for treating radioactively contaminated water in nuclear power plants | 6/91 | 7 a 11/01/92 | 2/80 | 19.06.01 | + |
| **3604** | Storaging, handling and on-site transportation of radioactive substances (other than fuel assemblies) in nuclear power plants | 6/83 | 194 14/10/83 Enclosure 47/83 | - | 14.06.94 | + |
| **3605** | Treatment of radioactively contaminated gases in nuclear power plants with light water reactors | 6/89 | 229 a 07/12/89 | - | 16.11.04 | + |
| | **<u>3700 Energy and media supply</u>** | | | | | |
| **3701** | General requirements for the electrical power supply in nuclear power plants | 6/99 | 243 b 23/12/99 | 3701.1 (6/78) 3701.2 (6/82) 6/97 | 16.11.04 | - |
| **3702** | Emergency power generating facilities with diesel-generator units in nuclear power plants | 6/00 | 159 a 24/08/00 | 3702.1 (6/88) 3702.2 (6/91) | - | - |
| **3703** | Emergency power generating facilities with batteries and rectifier units in nuclear power plants | 6/99 | 243 b 23/12/99 | 6/86 | 16.11.04 | - |
| **3704** | Emergency power facilities with rotary converters and static inverters in nuclear power plants | 6/99 | 243 b 23/12/99 | 6/84 | 16.11.04 | - |
| **3705** | Switchgear facilities, transformers and distribution networks for the electrical power supply of the safety system in nuclear power plants | 6/99 | 243 b 23/12/99 | 9/88 | - | - |
| **3706** | Measures to preserve resistance of electrical and I & C components against loss of coolant accident conditions of operating nuclear power plants | 6/00 | 159 a 24/08/00 | - | - | - |
| | **<u>3900 Other systems</u>** | | | | | |
| **3901** | Communication devices for nuclear power plants | 3/81 | 136 a 28/07/81 Enclosure 24/81 Addendum 155 22/08/81 | 3/77 | - | + |

| Rule no. KTA | Title | Most recent edition | Published in *Bundesanzeiger* / Federal Gazette No. dated | Earlier versions | Bestätigung der Weitergültigkeit | Engl. translation |
|---|---|---|---|---|---|---|
| **3902** | Lifting equipment in nuclear power plants | 6/99 | 144 a 05/08/99 | 11/75; 6/78; 11/83; 6/92 | 16.11.04 | - |
| **3903** | Inspection, testing and operation of lifting equipment in nuclear power plants | 6/99 | 144 a 05/08/99 | 11/82; 6/93 | 16.11.04 | - |
| **3904** | Control room, emergency control room and local control stations in nuclear power plants | 9/88 | 37 a 22/02/89 | - | 10.06.98 | + |
| **3905** | Load attaching points on loads in nuclear power plants | 6/99 | 200 a 22/10/99 | - | - | - |

( ) HTR rule which is no longer included in monitoring to section 5.2 of the KTA procedural instruction and is no longer available for purchase via Carl Heymanns Verlag KG.
1) The HTR specifications in this rule were also deleted at the same time.
2) At its 43rd meeting on 17 June 1989, the KTA adopted the “Instructions for users of rule KTA 3301 (11/84)".

## (g) References to Official National and International Reports Related to Safety

### Official National Reports


1. *Produktkontrolle radioaktiver Abfälle – Schachtanlage Konrad* – last updated 1995; edited by: Berndt-Rainer Martens; Salzgitter, December 1995; BfS ET-IB-45-REV-3
2. *Anforderungen an endzulagernde radioaktive Abfälle (Endlagerungsbedingungen, Stand: Dezember 1995) – Schachtanlage Konrad*; edited by Peter Brennecke; Salzgitter, December 1995; BfS ET-IB-79
3. *Anforderungen an endzulagernde radioaktive Abfälle und Maßnahmen zur Produktkontrolle radioaktiver Abfälle Endlager für radioaktive Abfälle Morsleben (ERAM) Teil I: Endlagerungsbedingungen, Stand: August 1996*; edited by Karin Kugel, Werner Noack, Heinz Giller, Berndt-Rainer Martens, Peter Brennecke; Salzgitter, August 1996; BfS ET-IB-85
4. *Anforderungen an endzulagernde radioaktive Abfälle und Maßnahmen zur Produktkontrolle radioaktiver Abfälle Endlager für radioaktive Abfälle Morsleben (ERAM) Teil II: Produktkontrolle, Stand: Dezember 1996*; edited by Berndt-Rainer Martens, Heinz Giller, Peter Brennecke; Salzgitter, December 1996; BfS ET-IB-85/2
5. *Anfall radioaktiver Abfälle in der Bundesrepublik Deutschland – Abfallerhebung für das Jahr 1998*; P. Brennecke, A. Hollmann; Salzgitter 1999; BfS ET 30/00
6. *Anfall radioaktiver Abfälle in der Bundesrepublik Deutschland – Abfallerhebung für das Jahr 1999*; P. Brennecke, A. Hollmann; Salzgitter April 2001; BfS ET 35/01
7. *Zusammenstellung der Genehmigungswerte für Ableitungen radioaktiver Stoffe mit der Fortluft und dem Abwasser aus kerntechnischen Anlagen der BRD (Stand Juli 2000)*; H. Klonk, J. Hutter, F. Philippczyk, Chr. Wittwer; Salzgitter 2000; BfS-KT-25/00
8. *Statusbericht zur Kernenergienutzung in der Bundesrepublik Deutschland 2001*; F. Philippczyk, J. Hutter, I. Schmidt; Salzgitter 2002; BfS-KT-27/02
9. Jahresbericht 2001 Bundesamt für Strahlenschutz *(Annual Report by the Federal Office for Radiation Protection)*; Salzgitter 2000
10. *Methoden und Anwendungen geostatistischer Analysen*; K.-J. Röhling; BMU 1999-529
11. *Sicherheit in der Nachbetriebsphase von Endlagern für radioaktive Abfälle*; 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
12. *Stellungnahme zum Stand der Entwicklung des Verfüll- und Verschließkonzeptes des Endlagers Morsleben (ERAM)*; R. S. Wernicke; BMU 1999-539
13. *Sicherheitstechnische Bewertung des Einlagerungsbetriebs im Endlager für radioaktive Abfälle Morsleben (ERAM) – Abschlussbericht* -; U. Oppermann, F. Peiffer; BMU 2000-547
14. *Sicherheitstechnische Bewertung des Einlagerungsbetriebs im Endlager für radioaktive Abfälle Morsleben (ERAM) – Berichtsband* – L. Ackermann, B. Baltes, J. Larue, H.-G. Mielke, U. Oppermann, F. Pfeiffer; BMU 2000-549
15. *Unsicherheits- und Sensitivitätsanalysen für Grundwasser- und Transportmodelle auf der Basis geostatistischer Untersuchungen*; K.-J. Röhling, B. Pöltl; BMU 2000-551
16. *Stellungnahme zu sicherheitstechnisch relevanten Erkenntnissen im Endlager Morsleben und Konsequenzen*; R. S. Wernicke; BMU 2000-552

17. *Simulation von Lüftungssystemen in Anlagen des Brennstoffkreislauf durch Erweiterung des Rechenprogramms FIPLOC*; G. Weber; BMU 2000-553
18. *Nuklidtransport bei salzanteilabhängiger Adsorption*; V. Javeri; BMU 2000-556
19. *Freigabe von Gebäuden und Bauschutt*; S. Thierfeldt, E. Kugeler; BMU 2000-558
20. *Flächenbezogene Freigabe und Freigabe von flüssigen Reststoffen*; A. Deckert, S. Thierfeldt, E. Kugeler; BMU 2000-559
21. *Grundsätzliche Aspekte für Verschlussbauwerke im Salinar – Stellungnahme zu einem Modell*; B. Baltes, R. S. Wernicke; BMU 2000-560
22. *Internationale Entwicklung zur Beurteilung der langzeitigen Sicherheit von Endlagern für HAW und abgebrannte Brennelemente*; B. Baltes; BMU 2001-562
23. *Geotechnische Nachweiskonzepte für Endlager im Salinar*; H.-G. Mielke; BMU 2001-580
24. *Betrachtungen zur Langzeitsicherheit und Machbarkeit anhand der TILA-99-Studie*; J. Larue; BMU 2001-581
25. *Nichtlineare Sorptionsansätze zur Beurteilung der Langzeitsicherheit*; K. Fischer-Appelt, H. Fischer, V. Javeri, K.-H. Martens, K. Röhling, E. Schrödl; BMU 2001-583
26. *Stabilitäts- und Integritätskriterien für salinare Strukturen*; V. Javeri, H.-G. Mielke; BMU 2001-585
27. *Migration von Salzlösung im ERAM*; K. Fischer-Appelt, J. Larue; BMU 2002-595
28. *Vergleich Untertagedeponien – Endlager*; Pieper, Resele, Skrzyppek, Wilke; BMU 2002-599
29. *Tongestein und Endlagerung radioaktiver Abfälle*; Th. Beuth; BMU 2002-603
30. *Erarbeitung einer optimierten Entsorgungsstrategie für Abfälle und Reststoffe aus Kernkraftwerken (Entsorgungsstrategie für radioaktive Abfälle)*; A. Nüsser, S. Thierfeldt, E. Kugeler, D. Gründler, D. Maric; BMU 2002-607
31. *Nuklidtransport – Salinität und nichtlineare Adsorption in der Gorlebener Rinne*; V. Javeri; BMU 2002-608

**Official International Reports**

1. Radioactive Waste Arisings in the Federal Republic of Germany, 1998 Waste Inquiry; P. Brennecke, A. Hollmann, Salzgitter, 2000; BfS ET 33/00
2. Radioactive Waste Arisings in the Federal Republic of Germany, 1999 Waste Inquiry; P. Brennecke, A. Hollmann, Salzgitter, 2001; BfS ET 36/01
3. Stochastic and Deterministic Analyses for a Generic Repository in Rock Salt in the EU-Project SPA “Spent Fuel Performance Assessment”, K.-H. Martens, H. Fischer, E. Hofer, B. Krzykacz, BMU 2000-550
4. *Betrachtungen zur Langzeitsicherheit und Machbarkeit eines Endlagers Yucca-Mountain*, H.-G. Mielke, BMU 2001-582
5. *Vergleich der Umweltverträglichkeitsprüfungen von Endlagern in Deutschland, Finnland und den USA*, H.-G. Mielke, BMU 2002-601
6. *Japanische Sicherheitsstudie zur Endlagerung*, L. Lambers, BMU 2002-602

**(h) References to Reports of International Review Missions Performed at the Request of a Contracting Party**

**(i) Other Relevant Material**

These documents may be used in the licensing and supervising procedure by the regulatory body if required.


| | | |
|---|---|---|
| [ABVO 96] | Allgemeine Bergverordnung über Untertagebetriebe, Tagebaue und Salinen vom 02. Februar 1966 (Nds. MBl. S. 337), zuletzt geändert durch die Bekanntmachung des Bundesministeriums für Wirtschaft nach § 25 der Allgemeinen Bundesbergverordnung über gegenstandslose landesrechtliche Vorschriften vom 10. Januar 1996 (BAnz 1996 S. 729) | p. 140 |
| [AKEnd 02] | Empfehlungen des AkEnd – Arbeitskreis Auswahlverfahren Endlagerstandorte, Dezember 2002 | p. 125, 126 |
| [ANT 78] | Antarktisvertrag BGBl. 1978 II S. 1517; UNTS Vol. 402 S. 71 | p. 148 |
| [BfS 95] | Bundesamt für Strahlenschutz (BfS), Anforderungen an endzulagernde radioaktive Abfälle (Endlagerungsbedingungen, Stand: September 1994) – Schachtanlage Konrad - Salzgitter, Dezember 1995, ET-IB-79 | p. 15, 17 |
| [BfS 02] | Jahresbericht des Bundesamtes für Strahlenschutz für 2000 „Umweltradioaktivität und Strahlenbelastung“, April 2002 | p. 151 |
| [BfS 04] | Umweltradioaktivität und Strahlenbelastung im Jahr 2003, BfS, 2004 | p. 151 |
| [BMU 99] | Übersicht über Maßnahmen zur Verringerung der Strahlenexposition nach Ereignissen mit nicht unerheblichen radiologischen Auswirkungen“, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Oktober 1999 | p. 86, 90 |
| [BMU 99a] | Handbuch Reaktorsicherheit und Strahlenschutz, Band 1, Teil D „Bilaterale Vereinbarungen im Rahmen der Kerntechnik und des Strahlenschutzes“, fortlaufende Aktualisierung | p. 90 |
| [BMU 00] | Sicherung von Zwischenlagern für bestrahlte Brennelemente aus Leichtwasserreaktoren an Kernkraftwerksstandorten in Transport- und Lagerbehältern gegen Störmaßnahmen oder sonstige Einwirkungen Dritter; BMU-Erlass vom 1. Dezember 2000, RS I 3 - 14640 - 1/7 VS-NfD | p. 98, 109 |
| [BUN 00] | Vereinbarung zwischen der Bundesregierung und den Energieversorgungsunternehmen vom 14. Juni 2000 („Konsensvereinbarung“) | p. 9, 11 |
| [DEC 00] | A. Deckert, S. Thierfeldt, E. Kugeler: Herleitung von Freigabewerten für flüssige Reststoffe. - Bericht erstellt im Rahmen des BMU-Vorhabens St.Sch. 4149, Brenk Systemplanung, Aachen, März 2000 | p. 79 |
| [DIN 25401] | Begriffe der Kerntechnik<br>DIN 25401-1: Begriffe der Kerntechnik - Physikalische und chemische Grundlagen<br>DIN 25401-2: Begriffe der Kerntechnik; Reaktorauslegung<br>DIN 25401-3: Begriffe der Kerntechnik - Reaktortechnik und Betrieb<br>DIN 25401-4: Begriffe der Kerntechnik; Kernmaterialüberwachung<br>DIN 25401-5: Begriffe der Kerntechnik; Brennstofftechnologie<br>DIN 25401-6: Begriffe der Kerntechnik – Isotopentrennung<br>DIN 25401-7: Begriffe der Kerntechnik; Sicherheit kerntechnischer Anlagen<br>DIN 25401-8: Begriffe der Kerntechnik; Strahlenschutz<br>DIN 25401-9: Begriffe der Kerntechnik; Entsorgung | p. 16 |
| [DIN 25403] | Kritikalitätssicherheit bei der Herstellung und Handhabung von Kernbrennstoffen, DIN 25403 Teil 1, Grundsätze vom Dezember 1991 | p. 109 |
| [DIN 25474] | Maßnahmen administrativer Art zur Einhaltung der Kritikalitätssicherheit in kerntechnischen Anlagen ausgenommen Reaktoren, Juli 1996 | p. 109 |

| | | |
|---|---|---|
| [EC 00] | European Commission: Recommended Radiological Protection Criteria for the Clearance of Buildings and Building Rubble Arising from the Dismantling of Nuclear Installations, Radiation Protection 113, 2000 | p. 79 |
| [EUR 92] | Richtlinie 92/3/EURATOM des Rates vom 3. Februar 1992 zur Überwachung und Kontrolle der Verbringungen radioaktiver Abfälle von einem Mitgliedstaat in einen anderen, in die Gemeinschaft und aus der Gemeinschaft Amtsblatt vom 12. Februar 1992, Nr. L 35 S. 24 | p. 146, 147 |
| [EUR 93] | Verordnung (EURATOM) Nr. 1493/93 des Rates vom 8. Juni 1993 über die Verbringung radioaktiver Stoffe zwischen den Mitgliedsstaaten (ABl. L 148/1) | p. 154 |
| [EUR 96] | Richtlinie 96/82/EG des Rates vom 9. Dezember 1996 zur Beherrschung der Gefahren bei schweren Unfällen mit gefährlichen Stoffen "Seveso II-Richtlinie" (Abl. Nr. L 10 vom 14. Januar 1997 S. 13) | p. 18 |
| [EUR 97a] | Richtlinie 97/43 des Rates vom 30. Juni 1997 über den Gesundheitsschutz von Personen gegen die Gefahren ionisierender Strahlung bei medizinischer Exposition und zur Aufhebung der Richtlinie 84/466/Euratom | p. 74 |
| [EUR 03] | Richtlinie 2003/122/EURATOM des Rates vom 22. Dezember 2003 zur Kontrolle hoch radioaktiver umschlossener Strahlenquellen und herrenloser Strahlenquellen (ABl. Nr. L 346 vom 31.12.2003 S. 63) | p. 151, 152, 153 |
| [G-8 03] | Aktionsplan der G-8 zur Nichtverbreitung, Beschluss auf dem G8-Gipfeltreffen in Evian-les-Bains (Frankreich), 3. Juni 2003 | p. 151 |
| [GG 49] | Grundgesetz für die Bundesrepublik Deutschland (GG) vom 23. Mai 1949 (BGBl. S. 1), zuletzt geändert durch Art. 1 G v. 26. Juli 2002 I 2863 Maßgaben aufgrund des EinigVtr vgl. GG Anhang EV | p. 12, 47, 64 |
| [HGB 02] | Handelsgesetzbuch, Gesetz vom 10. Mai 1897 (RGBl. S. 219), zuletzt geändert durch Gesetz vom 19. Juli 2002 (BGBl. I S. 2681) m. W. v. 26. Juli 2002 | p. 70 |
| [IAEA 94] | Design of Spent Fuel Storage Facilities (1994), IAEA Safety Series No. 116, Wien, 1994 | p. 108 |
| [IAEA 94a] | Operation of Spent Fuel Storage Facilities (1994), IAEA Safety Series No. 117, Wien, 1994 | p. 108 |
| [IAEA 94b] | Safety Assessment for Spent Fuel Storage Facilities, IAEA Safety Series No. 118, Wien, 1994 | p. 100 |
| [IAEA 95] | Principles of Radioactive Waste Management: A Safety Fundamental, Safety Series No. 111-F, STI/PUB/989, Wien, 1995 | p. 12, 17, 101, 119 |
| [IAEA 96] | International Basic Safety Standards for Protection against radiation and for the safety of radiation sources, Wien, 1996 | p. 18, 75, 86 |
| [IAEA 96a] | International Atomic Energy Agency: Regulations for the Safe Transport of Radioactive Material, 1996 Edition (revised), No. TS-R-1 (ST-1, Revised) | p. 109 |
| [IAEA 96F] | Radiation Protection and the Safety of Radiation Sources: A Safety Fundamental, Safety Series No. 120, STI/PUB/1000, Wien, 1996 | p. 12 |
| [IAEA 00a] | Predisposal Management of Radioactive Waste, Including Decommissioning, Safety Requirements No. WS-R-2, July 2000 | p. 119 |
| [IAEA 01] | Code of Conduct on the Safety and Security of Radioactive Sources, IAEA/CODEOC/2001, Wien, 2001 | p. 151 |
| [IAEA 02] | Core Management and Fuel Handling for Nuclear Power Plants, IAEA Safety Guide No NS-G-2.5, Wien, 2002 | p. 100 |
| [IAEA 03] | Categorization of radioactive sources, Revision of IAEA-TECDOC-1191, Categorization of radiation sources, ISBN 92-0-105903-5, IAEA-TECDOC-1344, Wien, 2003 | p. 151 |
| [IAEA 04] | Code of Conduct on the Safety and Security of Radioactive Sources, IAEA/CODEOC/2004, Wien, 2004 | p. 151, 155 |

| | | |
|---|---|---|
| [IAEA 04a] | Code of Conduct on the Safety and Security of Radioactive Sources: Guidance on the Import and Export of Radioactive Sources, GOV/2004/62-GC(48)/13, IAEA, Wien, 5 August 2004 | p. 151, 155 |
| [IAEA 04b] | Regulations for the safe transport of radioactive material: 1996 edition (as amended 2003). — Safety Requirements; Safety standards series, No. TS-R-1), STI/PUB/1194, IAEA, 228p., Wien, 2004 | p. 152 |
| [ICRP 84] | ICRP Publication 40 (Annals of the ICRP Vol. 14 No. 2, 1984), Protection of the Public in the Event of Major Radiation Accidents: Principles for Planning | p. 86 |
| [ICRP 93] | ICRP Publication 63 (Annals of the ICRP Vol. 22 No. 4, 1993), Principles for Intervention for Protection of the Public in a Radiological Emergency | p. 86 |
| [Linien 56] | Vereinbarung über den Durchflug im internationalen Linienverkehr (BGBl. 1956 II S. 442) | p. 149 |
| [Mosel 57] | Vertrag vom 27. Oktober 1956 über die Schiffbarmachung der Mosel (BGBl. 1956 II S. 1837, 1957 II S. 2) | p. 148 |
| [Rhein 69] | Revidierte Rheinschifffahrtsakte vom 17. Oktober 1868 in der Fassung der Bekanntmachung vom 11. März 1969 (BGBl. 1969 II S. 597) | p. 148 |
| [SSK 98] | „Freigabe von Materialien, Gebäuden und Bodenflächen mit geringfügiger Radioaktivität aus anzeige- oder genehmigungspflichtigem Umgang“, “, Berichte der Strahlenschutzkommission (SSK) des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit, Heft 16 (1998) | p. 79 |
| [SSK 99] | „Radiologische Grundlagen für Entscheidungen über Maßnahmen zum Schutz der Bevölkerung bei unfallbedingten Freisetzungen von Radionukliden“, Empfehlungen der Strahlenschutzkommission, GMBl.1999, S.538-587 | p. 87 |
| [SSK 01] | Strahlenschutzkommission: Fachgespräch zur Iodblockade der Schilddrüse bei kerntechnischen Unfällen, Stellungnahme der Strahlenschutzkommission, verabschiedet auf der 175. Sitzung der SSK am 13./14.12.2001 | p. 87 |
| [SSK 04a] | „Leitfaden für den Fachberater Strahlenschutz der Katastrophenschutzleitung bei kerntechnischen Notfällen“, Berichte der Strahlenschutzkommission (SSK) des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit, Heft 37 (2004) | p. 88 |
| [SSK 04b] | „Erläuterungsbericht zum Leitfaden für den Fachberater Strahlenschutz der Katastrophenschutzleitung bei kerntechnischen Notfällen“, Berichte der Strahlenschutzkommission (SSK) des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit, Heft 38 (2004) | p. 88 |
| [SSK 04c] | „Kriterien für die Alarmierung der Katastrophenschutzbehörde durch die Betreiber kerntechnischer Einrichtungen“, Berichte der Strahlenschutzkommission (SSK) des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit, Heft 39 (2004) | p. 87 |
| [THI 99] | S. Thierfeldt et al.: Stillegung von Kernanlagen – Freigabe von Bodenflächen kerntechnischer Standorte, Brenk Systemplanung, Aachen, 1999 | p. 90 |
| [UNCLOS 94] | Gesetz zu dem Seerechtsübereinkommen der Vereinten Nationen vom 10. Dezember 1982 (BGBl. 1994 II S. 1798) | p. 148 |

## Additional Report concerning the Remediation of the Wismut GmbH

This section deals with contaminated uranium mining and milling sites and their remediation.

### Development of the Wismut GmbH

In large areas of Saxony and Thuringia, the geological formations permitted the surface and underground mining of uranium ore on a large scale. Disused facilities of the former Soviet-German company Wismut are located at numerous sites where ore was mined and processed from 1946 until the early 1990s. Most recently, mining took place in underground mines, but there are also some older open pits. In the proximity of the mining operations, the ore was processed into an intermediate product (Yellow Cake) which was easy to transport. Up until 1990, uranium production totalled approximately 220000 Mg, making the Wismut company the third largest uranium producer in the world.

In the course of German reunification, one half of the shares of the bi-national Soviet-German company Wismut were taken over by the Federal Republic of Germany. The remaining Soviet shares were then taken over on the basis of German-Soviet agreement of May 16, 1991. The Wismut Act of 1991 decreed the transformation of Wismut into a limited liability company (*GmbH*). The only associate of this company is the Federal Republic of Germany, represented by the Federal Ministry for Economics and Labour. The Wismut GmbH is obliged to remediate its property. According to current estimates about 6.2 billion € will be required for the remediation work. These expenditures will solely be financed by the Federal Government. About 4.4 billion € have already been spent until the end of 2004.

### Amount of Heap Material and Tailings from Uranium Processing

Uranium mining and processing not only caused considerable surface damage and direct consequences of the mining work; what is more, it also gave rise to large quantities of radioactive and chemically toxic residues which had been disposed of above ground in mill-tailing ponds and on heaps. Table 1 gives an overview of the amount of waste rock material (country rock from ore mining) which are present at the various Wismut sites. Figure 1 shows an aerial view of the open pit mine at Ronneburg in the year 1993.

Table 1: Number of heaps and volume of waste rock material from uranium mining at the sites of the Wismut GmbH

| Site | Number of heaps | Volume in $10^6$ m³ |
|---|---|---|
| Ronneburg/Thuringia | 16 | 187.8 [i)] |
| Seelingstädt/ Thuringia | 9 | 72 |
| Schlema-Alberoda and Pöhla/Saxony | 20 | 47.2 |
| Königstein and Gittersee/Saxony | 3 | 4.5 [ii)] |
| **Total** | **48** | **311.5** |

[i)] incl. $6.3 \cdot 10^6$ m³ waste rock material from acid leaching and $75 \cdot 10^6$ m³ material dumped in the open pit
[ii)] incl. $1.9 \cdot 10^6$ m³ waste rock material from acid leaching and $0.3 \cdot 10^6$ m³ sludges from water treatment

Figure 1: Open pit mine at Ronneburg in 1993 (Picture L 278/16, © 1993 Wismut GmbH, Abt. Dokumentation / Überwachung Liegenschaften, Jagdschänkenstr. 29, 09117 Chemnitz)

The majority of the uranium ores were processed by acid and alkaline leaching, respectively. The volumes of the tailings originating from uranium ore processing are given in Table 2. The mean radionuclide contents of the waste rock material is usually below 100 mg/kg U and below 1 Bq/g Ra-226. The tailings usually show radionuclide concentrations between 100 and 150 mg/kg U with specific Ra-226 activities in the range between 10 and 15 Bq/g.

Table 2: Volumes of tailings from uranium ore processing at the sites of the Wismut GmbH

| Site | Number of tailing ponds | Volume in $10^6$ m³ |
|---|---|---|
| Seelingstädt/Thuringia | 4 | 108 |
| Crossen/Saxony | 2 | 51.6 [i)] |
| Schlema-Alberoda/Saxony | 2 | 0.6 [ii)] |
| **Total** | **8** | **160.2** |

i) incl. $3.2 \cdot 10^6$ m³ residues from gravimetric ore processing on heaps
ii) residues from gravimetric ore processing

The residues from former uranium ore mining and processing are, however, not regarded as radioactive waste for the following reasons:

According to Section 118 of the Radiation Protection Ordinance (StrlSchV) and Article 9, section 2 together with Appendix II, chapter XII, section III, nos. 2 and 3 of the German Reunification Act, the following regulations are to remain in force in the new Federal States of Germany with respect to the remediation of the legacy of past practices and the decommissioning and remediation of uranium mining and milling installations, provided radioactive substances, particularly radon decay products, are present:

- the GDR Ordinance on Nuclear Safety and Radiation Protection (*Verordnung über die Gewährleistung von Atomsicherheit und Strahlenschutz* - VOAS) of 11 October 1984 and its Implementing Regulation of 1984 (*Durchführungsbestimmung zur Verordnung über die Gewährleistung von Atomsicherheit und Strahlenschutz - DB zur VOAS*) and
- the Order of 1980 on Radiation Protection in Relation to Heaps and Industrial Repositories (*Anordnung zur Gewährleistung des Strahlenschutzes bei Halden und industriellen Absetzanlagen und bei der Verwendung darin abgelagerter Materialien - HaldenAO*) of 17 November 1990

These regulations have the status of statutory ordinances promulgated on the basis of the Atomic Energy Act, with the exception of two areas, namely, the protection of occupationally exposed personnel (Section 118, para. 3 of the StrlSchV), and emission and immission monitoring (Section 118, para. 3 of the StrlSchV), both of which are subject to the regulations of the Radiation Protection Ordinance. This approach was necessary because the Radiation Protection Ordinance does not apply to the remediation of mining sites, or at least only under certain circumstances. The radiation protection principles laid down in the VOAS are based on the recommendations of the ICRP (ICRP 26 of 1977 and ICRP 32 of 1981).

In order to categorise the material generated from past practices at uranium mines and other contaminated sites, recourse must be made to the definitions and exemption levels of the aforementioned regulations of the former GDR, given that they retain their validity. As such, the provisions of Section 2, para. 2 nos. 1 and 2 of the Atomic Energy Act, which state that the activity or concentration of activity of a substance may be disregarded if it falls below the exemption levels set out in Appendix III, tab. 1 col. 2 or 3 of the StrlSchV, do <u>not</u> apply here.

The Annex to the VOAS defines the following two categories of residual materials containing radionuclides, depending on the level of activity concentration:

- radioactive releases ("radioactive substance which is released to the environment with waste water or air or disposed of in solid form and whose activity concentration exceeds the specified exemption criteria for radioactive releases") and
- radioactive waste ("radioactive substance which cannot be re-used or recycled for scientific, technical and economic reasons and which is disposed of in such a way that it is isolated from the environment and whose activity and activity concentration levels exceed the exemption criteria stipulated for radioactive waste").

According to Section 28 of the Implementing Regulation for the VOAS, the exemption level for solid radioactive releases is 0.2 Bq/g. For radioactive waste, the exemption levels are the same as those for radioactive material, i.e. either an exemption level for the activity concentration of 100 Bq/g (or 500 Bq/g in the case of solid, naturally radioactive material); or alternatively, the exemption levels for total activity listed in Annex 2 of the Implementing Regulation for the VOAS (e.g. 5000 kBq for $U_{nat}$, 5 kBq for Ra-226; – in the case of more than one nuclide, the summation formula given in Section 28, para. 1 of the Implementing Regulation for the VOAS should be used). In summary, heaps and tailings and other waste material from Wismut sites are generally not classified as radioactive wastes within the meaning of VOAS or the Implementing Regulation for the VOAS.

**Sustainable Safekeeping of Legacies**

Even in 1990 the closure of mines and installations was initiated and first steps towards remediation of contaminated sites were carried out. These necessary immediate measures aiming at dose reduction for the population should, however, not impede with the later remediation as far as possible. At the same time, the inventory, registration and analysis of environmental detriments and environmental radioactivity were started. The Wismut GmbH developed a comprehensive remediation concept for carrying out the necessary remediation work which has been continuously adapted to the latest information and knowledge.

The competence for issuing licences for remediation work of the Wismut GmbH lies with the radiation protection authorities of the Federal States Saxony and Thuringia. According to Section 118 StrlSchV, decommissioning and remediation of uranium mining sites and remediation of legacies of former work activities are governed by VOAS, by the Implementing Regulation for VOAS and by the HaldenAO, which belong to the regulatory framework of the former GDR as described above. The only exception is the area of protection of occupationally exposed personnel and the emission and immission control, which are governed by the respective regulations of the StrlSchV. In the assessment and licensing procedures for remediation measures the basic requirements of justification, limitation of dose and optimization (according to the ALARA principle) have to be observed. The guiding level for the maximum effective individual dose for the general population at the end of the remediation work is 1 mSv/a as a long-term average.

Overall, the remediation issues are very complex. At the commencement of the work, the premises requiring remediation covered a total area of more than 37 km², with heaps accounting for a total area of approximately 15.2 km², and tailing ponds, in which the tailings resulting from uranium production are stored in the form of sludge, covering some 6.3 km². The open drifts and mine workings had a length of about 1400 km.

The overall remediation concept developed by the Wismut GmbH comprises all former mining sites and all processing facilities, including all appertaining areas, particularly waste rock dumps, tailing ponds etc. The most favourable remediation variant was chosen on the basis of this remediation concept taking into account ecological and economical aspects. When formulating this overall concept, it was important to bear in mind that the sites are located in close proximity to human settlements. The entire hydrology and hydrogeology also played an important role. The remediation of the underground mine Königstein posed particular challenges because there an underground leaching of uranium ore with sulphuric acid had taken place apart from conventional mining, which may lead to detrimental effects on an uncontaminated groundwater aquifer after flooding of the mine.

The overall concept for the remediation of former Wismut sites is structured as follows:

- The underground mine works (drifts and shafts) are partially backfilled.
- The mine works will subsequently be flooded by discontinuing the current measures to lower the groundwater table. This process may take a few years or several decades, depending on the site and the geological conditions.
- The open pit at the Ronneburg site, which had an initial open volume of about 84 million m³ at the start of the work, is being filled with material from the adjacent heaps. The material sequence and stratification has been optimised by means of hydrogeological and geochemical assessments. The filled pit will be flooded by discontinuing the current measures to lower the groundwater table.

- At many other sites, long-term measures will be necessary in order to treat the surfacing groundwater during and after the flooding process. It is estimated that it will be necessary to maintain these measures over long periods of time.
- The tailing ponds of the processing facilities will be kept in situ, i.e. there are no plans to relocate the tailings. The covering layer of water is removed and the exposed edges are successively covered in order to prevent the creation of dust. The remaining sludge is partially drained and secured by geotechnical measures to allow the construction of a stable cover which reduces the infiltration of rain water and the release of radon. Dams and ponds are reshaped and covered in order to increase stability and to blend in with the landscape.
- The waste rock dumps which are kept in situ as well as the waste rock material which has been relocated into the open pit at the Ronneburg site are covered with a mineral cover in order to reduce direct radiation, radon exhalation and dust creation as well as to reduce infiltration of precipitation. In this context the requirement of a barrier layer in the cover against oxygen access to avoid increased release of pollutants as a result of oxidation processes in the heap material has to be assessed.
- Hauling and processing plants are shut down. Like other buildings, they are being demolished for the most part. The building rubble is mainly incorporated into the open pit as well as into heaps and tailing ponds. After clearance measurements, the bulk of the metal scrap is recycled by melting.

During planning of remediation of the sites described above it has been and still is always necessary to assess whether a certain remediation action will provide a net benefit with respect to radiation exposure and other risks. The evaluation yardsticks used for this purpose include the maximum individual doses and the collective dose.

All of the aforementioned work has already progressed significantly and has been completed by about 2/3. The actual remediation works will last until about 2015, depending on the site. An extended phase of long-term maintenance measures will follow. The design and extent of the long-term monitoring programme for air and water pathways can only be substantiated and finalized after the end of remediation phase.

Contact:
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
Public Relations Division
D - 11055 Berlin
Fax: +49 (1888) 3 05 - 20 44
Internet: www.bmu.de
E-mail: service@bmu.bund.de

This brochure is part of the public relations work of the German Federal Government.
It is distributed free of charge and is not intended for sale.
Printed on 100 % recycled paper.

IT'S OUR FUTURE.