Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety

Convention on Nuclear Safety

Report by the Government of the Federal Republic of Germany for the Fifth Review Meeting in April 2011

IMPRINT

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Abbreviations

AtG	*Atomgesetz* Atomic Energy Act
ATWS	Anticipated transient without scram
BfS	*Bundesamt für Strahlenschutz* Federal Office for Radiation Protection
BMU	*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit* *- Bundesumweltministerium -* Federal Ministry for the Environment, Nature Conservation and Nuclear Safety - Federal Environment Ministry -
BMBF	*Bundesministerium für Bildung und Forschung* Federal Ministry of Education and Research
BMWi	*Bundesministerium für Wirtschaft und Technologie* Federal Ministry of Economics and Technology
BWR	Boiling water reactor
CSS	Commission on Safety Standards
GRS	Gesellschaft für Anlagen- und Reaktorsicherheit
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IRRS	Integrated Regulatory Review Service
KFÜ	*Kernkraftwerk-Fernüberwachungssystem* Remote monitoring system for nuclear power plants
KTA	*Kerntechnischer Ausschuss* Nuclear Safety Standards Commission
LAA	Länderausschuss für Atomkernenergie Länder Committee for Nuclear Energy
LOCA	Loss of coolant accident
MOX	Mixed oxide
NUSSC	Nuclear Safety Standards Committee
OECD/NEA	Organisation for Economic Co-operation and Development/ Nuclear Energy Agency
OSART	Operational Safety Review Team
PSA	Probabilistic safety analysis
PSR	Periodic safety review
PWR	Pressurised water reactor
RHWG	Reactor Harmonization Working Group
RODOS	Decision support system

RSK	*Reaktor-Sicherheitskommission* Reactor Safety Commission
SMS	Safety management system
SSK	*Strahlenschutzkommission* Commission on Radiological Protection
SR	Safety review
StGB	*Strafgesetzbuch* Penal Code
StrlSchV	*Strahlenschutzverordnung* Radiation Protection Ordinance
TÜV	*Technischer Überwachungs-Verein* Technical Inspection Agency
UVM BW	*Ministerium für Umwelt, Naturschutz und Verkehr Baden-Württemberg* Ministry of the Environment, Nature Conservation and Transport Baden-Württemberg,
VGB	VGB Power Tech e. V., formerly “Technische Vereinigung der Großkraftwerksbetreiber“
WANO	World Association of Nuclear Operators
WENRA	Western European Nuclear Regulators’ Association

Introduction

General conditions for the use of nuclear energy in the Federal Republic of Germany

Overview of the nuclear energy policy of the Federal Republic of Germany

The legal basis for the operation of German nuclear power plants, the Atomic Energy Act (AtG), was amended in 2002 with the aim to phase out the use of nuclear energy for the commercial production of electricity in a structured manner. The Act lays down the electricity production rights for each nuclear power plant. The electricity volume allocated per plant corresponds to a standard operating life of 32 years.

As noted in the policy statement by Federal Chancellor Merkel of 10 November 2009, the Federal Government focuses on an energy mix which gradually replaces the conventional sources of energy by renewable energies. For a transitional period, nuclear energy will remain an indispensable part of the energy mix as a bridge technology. The Federal Government is therefore prepared to extend the operating lives of the German nuclear power plants in compliance with the rigorous German and international safety standards and to use a substantial part of the additional profits of the power plant operators to accelerate the way into the age of regenerative energy, for example through increased research on energy efficiency and on the storage technologies.

Currently, the Federal Government is working on an energy concept which is to ensure a clean, reliable and affordable energy supply. This energy concept will be submitted in autumn 2010.

Overview of the national nuclear programme

The first nuclear power plant was commissioned in Germany in the years 1960/61, the last commissioning of a nuclear power plant was in the years 1988/89.

Currently, there are 17 nuclear power plants units in Germany whose residual electricity production rights have not been exhausted yet.

Obligations of the Federal Government of Germany under the Convention on Nuclear Safety and survey of the main safety issues addressed

The Federal Government considers the Convention on Nuclear Safety to be an important tool to ensure and improve the safety of the operation of nuclear power plants nationally and worldwide. Ensuring and enhancing the safety of operating plants continuously must have the highest priority. Irrespective of the position of the Federal Government on the necessity of the use of nuclear energy for commercial electricity production, Germany is committed to its international obligations, especially to the fulfilment of its obligations under the Convention on Nuclear Safety.

Within the reporting period, the main safety issues concerned, among others, the development of the new Safety Criteria for Nuclear Power Plants and their application on a trial basis which already started, the conduct of the IRRS mission (IRRS = Integrated Regulatory Review Service), the introduction and optimisation of the safety management systems, the upgrading of the sump strainers and the improvement of the reliability of power supply systems of specific NPP components.

Preparation of the report

Those organisations have jointly participated in the preparation of this fifth report of the Government of the Federal Republic of Germany which are concerned with the safety of nuclear power plants. These are, in particular, the nuclear authorities of the Federation, supported by their expert organisations, the nuclear authorities of the *Länder*, as well as the four power utilities which operate nuclear power plants in Germany.

This report largely follows the provisions of INFCIRC/572 Rev. 3 “Guidelines regarding National Reports under the Convention on Nuclear Safety” as regards structure, format and content.

Like the previous reports, this report has been conceived as a complete and closed representation and does therefore not merely confine itself to the changes since the Fourth Review Meeting. The individual chapters have been largely rewritten and adapted to the Guidelines regarding National Reports. In the chapter on Article 6 and in Appendix 2, information on research reactors has been included - as already in the previous reports - even though research reactors are not nuclear installations as defined by the Convention.

To demonstrate that the obligations have been fulfilled, the relevant acts of law, ordinances and regulations are indicated for each Article of the Convention. In the text for each chapter it is explained how the essential safety requirements are fulfilled and what corresponding measures have been taken by the operators of the nuclear installations. Focal issues of this fifth national report are the licensing procedure and regulatory supervision as well as the measures taken to improve nuclear safety.

The Appendix contains the list of the nuclear power plants and research reactors that are currently in operation or decommissioned, a compilation of the design basis accidents and beyond design basis accidents to be taken into account in the safety review, an overview of safety-relevant features of the operating nuclear power plants (nuclear installations as defined by the Convention), itemised by type and construction line of the nuclear power plants, and a comprehensive list of the legal provisions, administrative regulations, rules and guidelines in the nuclear area that are relevant to the safety of the nuclear power plants according to the Convention and which are referred to in the report.

Those involved in the preparation of the German report have based their work on:

- the results of the Fourth and previous Review Meetings,
- the focal points of the questions that were posed to Germany as Contracting Party on the occasion of the Fourth Review Meeting,
- the results of the consultations within Country Group 5 of the Fourth Review Meeting, and
- the announcements made by Germany as Contracting Party at the previous Review Meetings.

The above items were used to derive major points for in-depth review and discussion among those involved during report preparation.

The report by Germany as Contracting Party was approved by the Cabinet of Ministers of the Federal Government at its meeting on 4 August 2010.

Summary of the main results since the Fourth Review Meeting

In the following, the main results and activities in the field of ensuring nuclear safety since the Fourth Review Meeting in 2008 are presented, also including issues addressed in the Rapporteur's report on Germany.

The obligations under the Convention on Nuclear Safety are an important tool for the further development of all factors influencing nuclear safety and radiation protection.

In Germany, 17 nuclear power plant units are in operation. Nuclear safety of these plants and the protection of the employees and the public is a priority concern of the plant operators and the nuclear regulatory authorities. The safety of the plant is continuously reviewed within the framework of regulatory supervision. In case of new safety-relevant findings, the necessity of improvements is determined.

Additional comprehensive safety reviews (SRs) are required pursuant to the Atomic Energy Act after every ten years of operation. Since 2007, they had been conducted in nine nuclear power plants.

Safety requirements and regulations

The contents of Council Directive 2009/71/EURATOM of the European Union of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations [1F-1.25] to be implemented will be transposed into the German nuclear law in a legally binding form by 22 July 2011.

In recent yeas, the reporting criteria have been revised along with the amendment of the Nuclear Safety Officer and Reporting Ordinance [1A-17]. For practical considerations, the reporting criteria will, in future, be subdivided into separate technical parts for nuclear power plants, for research reactors, for facilities of the nuclear fuel cycle, for all decommissioned nuclear installations as well as for the storage of spent fuel elements. The amended Nuclear Safety Officer and Reporting Ordinance entered into force in summer 2010.

In April 2009, the draft of the new "Safety Criteria for Nuclear Power Plants" was presented. The Federation and the *Länder* agreed on a procedure providing application on a trial basis in parallel to the existing rules and regulations (→ Article 7). A comprehensive consultation procedure, involving the *Länder*, power utilities and science, aims to gain practical experience with the draft of the new Safety Criteria on the basis of which the draft is to be revised. The Federation and the *Länder* are striving for a unanimous adoption of the nuclear rules and regulation.

Within the reporting period, the draft Action Plan for transposition of the WENRA reference levels into the national nuclear rules and regulations has been updated. The progress of work is reported to the WENRA RHWG. The transposition is agreed upon by the BMU and the nuclear authorities of the *Länder*.

The safety standards of the Nuclear Safety Standards Commission (KTA safety standards) are regularly reviewed for their validity. If necessary, they are revised or newly developed. From 2007 to 2009, 13 KTA safety standards were revised, one new KTA safety standard developed and 4 new KTA safety standards have been initiated.

Conduction of the IRRS mission in Germany

In 2008, an IRRS mission of the IAEA was conducted at the Federal Environment Ministry (BMU) and the Ministry of the Environment, Nature Conservation and Transport Baden-Württemberg (UVM BW) at the invitation of the Federal Government with regard to the safety of nuclear power plants and individual aspects of radiation protection. The self-assessment process carried out in preparation of the mission and the results of the mission itself were generally assessed positively. Improvement measures have been initiated. The recommendations and suggestions of the IRRS mission have been considered in the action plans of the BMU and the UVM BW. The supplemented action plans specify further improvement measures.

Germany will invite to conduct an IRRS follow-up mission. The BMU and the UVM BW will present the measures taken in response to the recommendations and suggestions within the framework of the follow-up mission.

The regulatory body and its staffing

The effectiveness of the regulatory body in Germany is to be further developed and optimised on the basis of the existing competences at the federal and the *Länder* level under consideration of the recommendations and suggestions of the IRRS review team. The staffing situation is to be improved, as far as required. The competent federal and *Länder* authorities collaborate to this end.

Safety management and staff qualification

In the last years, the management systems of the nuclear power plants have been further developed. In addition to the structural organisation, the procedural organisation was documented in a process-based manner in supplement to the already existing written operating procedures. Sets of indicators that take into account the international standard and the process assessment have been introduced and further developed. The further development and optimisation of the safety management system based on the results of effectiveness reviews are an ongoing task for the operator. Within the next years, the introduction of the process-oriented management system is to be finalised in all plants.

The exchange of experience among the German plant operators has resulted in that the licensees largely follow a process-oriented approach for the management systems. In addition to the management processes it also covers the safety-relevant operating processes. In safety standard [KTA 1402], currently being developed, the requirements on the management system are to be further specified. The KTA safety standard is largely completed and will be submitted in 2010 for discussion.

Using the results of reviews, audits and evaluation of indicators, the supervisory authority is able to evaluate the effectiveness of the safety management system for each facility and to recognise the progress made towards the achievement and the development of safety objectives.

This process will also continue to be monitored within the framework of the supervisory procedure of the *Länder*. In this respect, the following aspects are to be considered:

- Verifications and regular reporting on the fulfilment of the requirements resulting from the current state of the art in science and technology for the introduction, application and improvement of their management systems.
- Methods and reliability of the effectiveness review practised by the licensees (derivation from the safety objectives, indicators, independent internal or external checks (as for example management reviews and audits), systematic comparison with other plants and plant operators (as for example peer reviews, benchmarking)).
- Methods of the regular regulatory verification on the establishment and application of management systems, giving due priority to nuclear safety, by the licensees including issues relating to the interactions and potential reciprocal effects of the effectiveness review by the licensee and the supervisory authority.
- An international comparison of regulatory requirements for the safety management and the resulting measures is to be made within the supervisory process to ensure the compliance of the national requirements with the state of the art in science and technology.

On the basis of the recommendations of the Reactor Safety Commission and the more specific consultations on the communication at the control room and its recordings as well as the supervisory review of the operators' safety culture, the following activities are planned for the next years:

- Further investigations into audio recordings at the power plant control room, and
- development of standardised national criteria for procedures regarding the regulatory review of the safety culture.

The requirements for measures to maintain technical competence (→ Article 11) of the nuclear power plant management personnel were defined precisely and have been implemented. Guideline [3-2] relating to the proof of the technical qualification of nuclear power plant personnel which, among others, contains specific requirements for the technical qualification of responsible personnel, is currently being revised. This includes, in particular, the adjustment of the times required according to practical experiences.

The power plant operators are currently developing a guideline with recommendations on the control of learning success. The introduction of the systematic, process-oriented reorganisation of training will take place on the basis of this guideline in accordance with the cycle process "Systematic Approach to Training" (SAT) recommended by the IAEA. This cycle process is based on fundamental elements of a quality management system. For going through the individual process steps, success and effectiveness controls are prescribed at selected distinct points. The completion and success of a training course will be evaluated in several ways to be able to assess, on the one hand, the effectiveness and, on the other hand, the quality of a training and advanced training event and, where possible, to show potential for improvement. Completion of the guideline is targeted for 2010.

Assessment and verification of safety

One of the activities in the field of design against earthquakes was the revision of KTA safety standard 2201.1 "Design of Nuclear Power Plants against Seismic Events; Part 1: Principles" which has been available as draft safety standard since September 2009. For the first time, probabilistic methods were included in the requirements for the earthquake-related design in accordance with this safety standard.

Within the scope of a research project, it was examined by means of exemplary studies on the impacts of climate change in Central Europe which impacts the climate change may have on the hazard to nuclear power plants in respect of meteorological events in Germany. From these, it can be concluded that for the sites of the German nuclear power plants, it is not to be expected that the hazard due to such events will considerably increase during the next decades. However, adaptations of the protection concepts may become necessary, depending on the specific site conditions.

Safety standard [KTA 1201] on safety specifications was revised and restructured under consideration of the further development of knowledge and the operating requirements. Additional requirements were included on plant start-up and shutdown and plant outage (shutdown states). Moreover, requirements were added on regulations for the control of design basis accidents during shutdown states. The requirements for the protection goal oriented part of the operating manual and transition to the accident management manual were also modified.

Further developments are considered with regard to the probabilistic assessment of the protection of nuclear power plants against external hazards within the scope of the safety reviews (SRs) (→ Article 14 (i)): As the requirement to carry out probabilistic analyses for external hazards was included in PSA guideline [3-74.1] as recently as 2005, the corresponding subordinate documents [4-7] are not fully developed yet. Based on initial experiences with the implementation of the methods for probabilistic safety analyses of nuclear power plants (“PSA methods” [4-7]) and additional theoretical considerations, the corresponding chapters are to be revised in the next years.

In November 2005, the Nuclear Safety Standards Committee (KTA) passed the decision to initiate project work on a new KTA safety standard on the topic of ageing management. The work was started in May 2006. Since 11/2009, safety standard [KTA 1403] “Ageing Management in Nuclear Power Plants” has been available as a draft.

Since 2007, comprehensive safety reviews (SRs), required pursuant to the Atomic Energy Act after every ten years of operation, had been conducted for the nuclear power plants Grafenrheinfeld, Krümmel, Philippsburg-2, Isar-2, Emsland, Gundremmingen B and C and Neckarwestheim-1 and -2. For the plants Grohnde and Biblis B, completion is scheduled for the end of 2010.

In response to the request put forward to Germany at the Fourth Review Meeting, Article 14 gives an outline of the methods for safety assessments within the framework of the transfer of electricity production rights applied for.

Safety improvements

In the last years, improvements were focused on modernisation measures, the implementation of technological progress to further enhance precautionary measures against damage and the feedback due to GRS information notices and operating experiences.

These improvements comprise numerous individual measures; some examples will be highlighted in the following:

1. The insulating material and, partially, the insulation cassette systems were exchanged within the scope of the sump issue. In all PWRs concerned, the sump strainers were upgraded to smaller mesh sizes and equipment for backflushing was implemented including the appropriate procedures.
2. The fire protection precautions, fire warning systems and ventilation systems were upgraded.
3. In several plants, plant-internal flood protection was further optimised.
4. With regard to aspects of system reliability, the power supply of individual components was optimised, e.g. by extending the emergency power supply. In addition, the response levels of motor protection relays of safety-relevant systems were adjusted.
5. In all plants, the instrumentation and control was further optimised and improved. The measures taken comprise, for example, changes of interlocking mechanisms, optimisation of the threshold values and backfitting of the process computers as well as the segregation of controls to enhance reliability of the emergency power supply.

In terms of plant-specific improvements, upgrades are implemented that, as a result of periodic safety reviews, turned out to be expedient to further enhance the safety level of the plants.

Evaluation of operating experience

Germany will actively participate in the further development of the reporting and evaluation systems for operating experience at international organisations. In the future, continuous information of the public via the BfS website is planned.

Regarding the feedback of operating experience, the following is planned:

– Improvement of feedback subsequent to information notices with regard to the content- and time-related boundary conditions,
– strengthening of the activities of the *Länder* in international co-operation,
– comparisons with the requirements and processes for experience feedback at other supervisory authorities with the aim to identify improvement potential,
– evaluation of events below the reporting threshold.

Radiation protection and emergency preparedness

In the reporting period, the regulatory guidance instruments on radiation protection and emergency preparedness were updated to a considerable extent. The revision of different guidelines and regulations to adapt them to the regulations of the Radiation Protection Ordinance and to take the current state of the art in science and technology into account was continued.

At the end of 2008, the Basic Recommendations for Disaster Control in the Vicinity of Nuclear Facilities [3-15.1] were republished in a revised form. The Radiological Bases for Decisions on Measures for the Protection of the Population against Accidental Releases of Radionuclides [3-15.2] were subjected to editing and republished together with the Basic Recommendations. At present, the Radiological Bases are being subjected to technical proof reading with the aim of a fundamental revision to adapt them to international developments and to the state of the art in science and technology.

According to the revised Basic Recommendations, the disaster control authority has to develop a substantiated concept to inform the public which is to be included in the disaster control plans. To this end, the SSK prepared a guideline [4-12] and published it in 2008. This guideline contains suggestions and instructions for the preparation of the required concept.

The operators specified criteria for the determination of potential radiological impacts as information for the off-site disaster control planning. The corresponding estimations refer to analyses of the event sequences that are considered in the *on-site* emergency planning and during which releases may occur that require disaster control measures in the environment of the plant. Draft safety standard [KTA 1203] “Requirements for the Accident Management Manual” was prepared.

The aim is to further develop technical and organisational co-operation for coping with radiological events. This includes national exercises under participation of several *Länder*, the integration of external observers and the performance of international exercises in areas near to the border.

6 Existing nuclear installations

ARTICLE 6 EXISTING NUCLEAR INSTALLATIONS

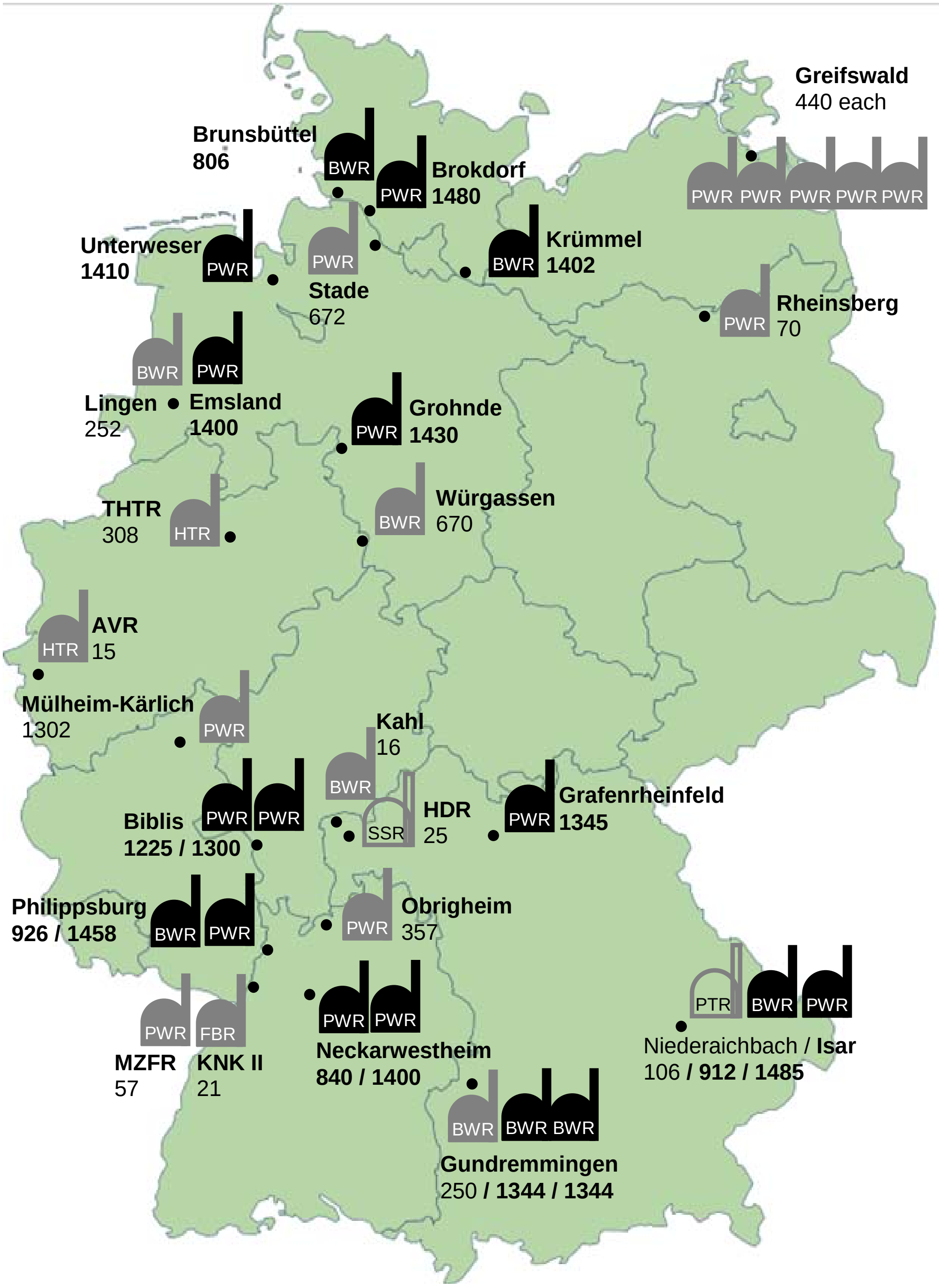
Each Contracting Party shall take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention enters into force for that Contracting Party is reviewed as soon as possible. When necessary in the context of this Convention, the Contracting Party shall ensure that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shut-down may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact.

Nuclear installations as defined by the Convention

In Germany, there are 18 nuclear installations as defined by the Convention. Currently, 17 nuclear power plant units are in operation at 12 different sites producing a total of 21 507 MWe (→ Figure 6-1). Appendix 1-1 presents an overview of the nuclear power plants in operation.

The Obrigheim nuclear power plant (KWO - 357 MWe PWR) was shut down on 11 May 2005 after the legally granted electricity production rights had been used up. On 21 December 2004, the plant operator had filed an application for decommissioning. The licence was granted on 28 August 2008. The fuel elements have been removed from the core but are still in an external spent fuel pool in the emergency building of the plant. Thus, it is still deemed as a nuclear installation as defined by the Convention.

According to the time of their construction, the nuclear power plants in operation can be classified according to three construction lines for pressurised water reactors, and to two different construction lines for boiling water reactors. The classification of the plants according to construction lines can be found in Appendix 1-1 and is henceforth used in this report. Appendix 4 contains a compilation of basic safety-relevant plant characteristics of the different construction lines for the areas of pressure boundary, emergency core cooling, containment, limitations and safety I&C (including reactor protection), electrical power supply as well as protection against external events. In order to illustrate the development, construction line 1 was also presented here to which the two plants under decommissioning (KWO, KKS) are to be assigned to.



12/2009

Legend

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

Numbers indicate gross capacity [MWe]

Figure 6-1 **Nuclear power plants in Germany**

Operation of the nuclear installations as defined by the Convention

In 2008, the electricity generated by German nuclear power plants amounted to 148.8 TWh. This corresponds, in 2008, to 23.3 % of the gross power production in Germany.

Table 6-1 Average availability of German nuclear power plants

Year	Time availability %	Energy availability %	Energy utilisation %
2009	73.2	74.2	71.2
2008	80.0	77.9	74.9
2007	76.0	76.4	74.4
2006	91.1	90.8	89.1
2005	88.8	88.0	86.3

Time availability: available operating time/calendar time
Energy availability: available energy/nominal energy
Energy utilisation: energy generated/nominal energy

Use of mixed oxide (MOX) fuel elements

The utilisation of plutonium from the reprocessing of irradiated fuel elements from German nuclear power plants in other European countries takes place through the use of mixed oxide (MOX) fuel elements in nuclear power plants. The plutonium in the form of MOX fuel elements can be fully utilised so that no residual amounts of plutonium will remain until cessation of plant operation.

In Germany, mixed oxide fuel elements are not used in the plants for economic reasons, but due to the utilisation obligation under Section 9a para 1 of the Atomic Energy Act. Since 1 July 2005, the transport of spent fuel elements for reprocessing has been ended. A large part of plutonium supplied by then in spent fuel elements has already been separated and processed into MOX fuel elements.

The higher content of plutonium in MOX fuel elements leads to a harder neutron flux spectrum and thus to changes of the reactivity coefficients. In pressurised water reactors, the resulting reduction of the effectiveness of the absorbers is compensated, among others, by the use of use of B-10 enriched boric acid. In the licensing procedures it has been demonstrated that the control of all transients and design basis accidents is also ensured with a limited number of MOX fuel elements in the core.

The competent authorities of the *Länder* have issued licence permits for the use of MOX fuel elements in ten pressurised water reactors. The individually licensed deployable amounts lie between 9 % and 50 % of the total number of fuel elements in the core.

In the case of boiling water reactors, for the two units at Gundremmingen (KRB B and C), e.g., licences have been issued to deploy up to 38 % of MOX fuel elements in the core. For the Krümmel nuclear power plant, a licensing procedure is underway regarding the use of MOX fuel. To date, a maximum of 33 % of MOX fuel elements have been used for core loading in pressurised water reactors and 24 % in boiling water reactors.

Most of the nuclear power plants have already been issued licence permits to increase the initial enrichment of U-235 to values of up to 4.6 weight % and the content of fissile plutonium in MOX fuel elements. It will then be possible to achieve a burn-up of more than 60 GWd per ton of heavy metal.

Modification licences

In the years 2007 - 2009 (February), a total of 12 modification licences were granted for the nuclear power plants which concerned safety-related improvements. Nine of these modification licences related to technical modifications or modifications in the mode of operation.

One nuclear power plant was granted a licence to increase enrichment to 4.45 weight % (Brokdorf). For the Brunsbüttel plant, a licence was granted for the use of uranium fuel elements for rod-averaged burn-ups above 59 MWd/kgU. Further licences related to, for example, the installation and operation of catalytic recombiners for hydrogen removal after severe accidents (KWB-A) and retrofitting of the reactor power I&C in the Philippsburg-2 nuclear power plant to the digital process control system TELEPERM-XS.

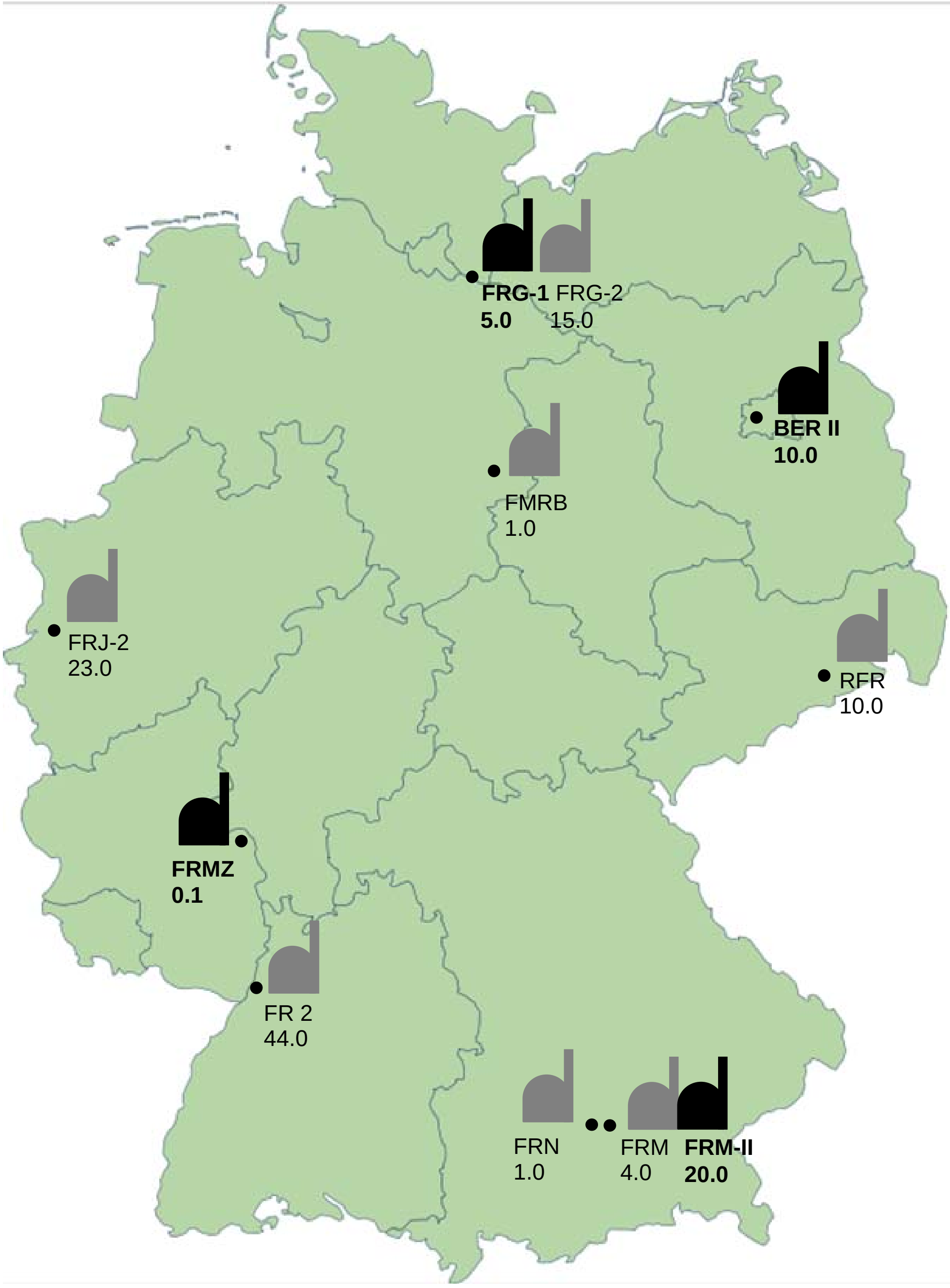
Research reactors

Research reactors do not present nuclear installations as defined by the Convention. Report on them is given in compliance with the recommendation stated in the "Code of Conduct on the Safety of Research Reactors" of 2004.

In Germany, four research reactors with a capacity of more than 50 kW thermal power are in operation (→ Appendix 2-1). The operators of the research facilities are public or state-sponsored universities and research centres. Eight research reactors have been decommissioned and are being dismantled (→ Appendix 2-2) (as of September 2009), another 28 research reactors and zero-power training reactors have already been dismantled completely (→ Appendix 2-3). Moreover, four training reactors are in operation: with a power of 2 W in Dresden and a power of 100 mW each in Furtwangen, Stuttgart and Ulm. Another two training reactors still have an operating licence (as of May 2009) but are no longer used. Figure 6-2 shows the sites of research reactors with a capacity of more than 50 kW thermal power. The research reactors in operation reach capacities of up to 20 MW.

For licensing and supervision of research reactors, the nuclear regulations for power reactors are applied, among others, adapted to the requirements to be imposed for research reactors, Depending on the risk potential of the respective research reactor, a multi-level approach is applied by the nuclear licensing and supervisory authorities of the *Länder* competent according to nuclear law.

Research reactors with a capacity of more than 50 kW thermal power are, as the power reactors, subject to the obligations to report in case of reportable events (→ Article 19 (vi)). In this respect, the reporting criteria are adapted to research reactors.



12/2009

Legend

in operation

in decommissioning or decommissioning decided

Numbers indicate thermal power [MW]

Figure 6-2 Research reactors > 50 kW in Germany

Other nuclear installations

To complete the picture of the utilisation of nuclear energy in Germany, a short survey of the other nuclear installations also outside the scope of the Convention will be presented. However, some of these installations are subject to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management about which last report was given by Germany within the framework of the Third Review Meeting in May 2009.

Altogether, 19 nuclear power plant units are under decommissioning or have already been decommissioned, one of them still containing fuel (→ Appendix 1-2). From these, 15 nuclear power plants are currently being dismantled, two nuclear power plants are in safe enclosure and two plants have already been completely dismantled.

The other nuclear installations are facilities of the nuclear fuel cycle and for the treatment and final disposal of radioactive waste (except for interim storage facilities and repositories). A uranium enrichment plant at Gronau and a fuel element fabrication plant at Lingen are in operation. The reprocessing plant at Karlsruhe finally ceased operation and is in the process of being dismantled. Since September 2009, the fission products still present there have been vitrified at the on-site vitrification plant and, thus, prepared for final disposal.

Several fuel fabrication plants have completely been dismantled. A number of facilities in operation serve the purpose of interim storage of fuel elements as well as the treatment, conditioning and interim storage of radioactive waste. Central interim storage facilities and local interim storage facilities serve the purpose of interim storage of spent fuel elements (→ Article 19 (viii)). The licensing procedure for the pilot spent fuel conditioning plant in Gorleben (PKA) was completed in December 2000 with the granting of the third partial construction licence. According to the agreement between the Federal Government and the power utilities of 11 June 2001, the use of the plant shall be limited to the repair of defective containers.

Until September 1998, the Morsleben repository (ERAM) was in operation for the disposal of low-level and medium-level radioactive waste. The plan approval procedure for decommissioning is underway. Until 1978, low-level and intermediate-level waste was emplaced in the Asse II mine. Since 2009, the facility has been operated by the Federal Office for Radiation Protection and is to be decommissioned according to nuclear law. The plan approval procedure for the Konrad repository was ended with the plan approval decision which became final in April 2007. Refitting of the Konrad repository started in May 2007. It is planned to take the repository into operation after completion of the refitting work by the end of 2014.

The exploration work in the Gorleben mine was interrupted in 2000; the duration of this moratorium shall be at least 3 and at most 10 years. In their coalition agreement, the federal government parties stipulated to lift the moratorium on the exploration of the Gorleben salt dome immediately for unbiased further exploration. An international peer review group should accompany the work and examine if Gorleben complies with the latest international standards. The entire process is to be designed in a public and transparent way.

Overview of important safety issues (including events)

Due to operating experience and events (fire in a main transformer, → Article 14) in the reporting period, the methods for dealing with events and the communication at the control room were reviewed. The focus here was on the communication between shift personnel during switching operations and structural improvements in the management of events. Furthermore, in some plants, ventilation systems were modified such that no harmful gases can penetrate into safety-relevant areas in case of smoke development at the plant site. In these fields, different optimisation measures are currently being assessed and dealt with within the framework of supervisory procedures.

Due to indications in suction pipes of valves with Bredtschneider closure in two BWR plants, safety-relevant valves with austenitic housings were subjected to tests on the inner surface. The cause was chloride-induced stress corrosion cracking or pitting corrosion. The valves affected, partly belong to the reactor coolant pressure boundary, partly they are of importance for the function of the systems. Due to the limited crack depth, the integrity of the valves had not been impaired. Reviews at other plants in Germany revealed no indications to a comparable extent. The operators developed and implemented plant-specific repair concepts.

Due to the generic significance, the issue of sump clogging by insulation material during loss-of-coolant accidents was also investigated systematically for German plants. The investigations and the consequences derived are described in detail in Article 14. The improvement measures are currently being implemented plant-specifically in PWRs. For BWRs, the measures required are being examined.

Triggered by the Forsmark event in July 2006, the operators launched an extensive investigation programme in close co-operation with authorities and authorised experts as regards the possible vulnerability of emergency power supply to external events. This programme is currently being implemented.

Overview of planned programmes and measures for continuous improvement of safety

The safety of the plant is continuously reviewed within the framework of regulatory supervision. In case of new safety-relevant findings, the necessity of improvements is determined. Detailed descriptions are given under Articles 14, 18 and 19. This also contributes to further developing plant safety.

Safety reviews

Since 2007, additional safety reviews (SRs) required by law had been conducted for the nuclear power plants Neckarwestheim-1, Gundremmingen-B, Gundremmingen-C, Grafenrheinfeld, Krümmel, Philippsburg-2, Isar-2, Emsland and Neckarwestheim-2. For the plants Grohnde and Biblis B, completion is scheduled for the end of 2010.

Research for the safety of nuclear installations as defined by the Convention

For the Federal Government, the safe operation of the nuclear power plants has top priority. In this context, research for the safe operation of nuclear power plants is continued and extended. Furthermore, from the point of view of the Federal Government, it is to be ensured by research projects to maintain the capability to also judge the safety of nuclear power plants in neighbouring countries based on own expertise. It is monitored to what extent the objectives of international developments are actually achieved with regard to further increased reactor safety, increased economical operation, proliferation resistance and reduction of radioactive waste.

The Federal Republic of Germany participates in the world-wide efforts to further develop the safety of nuclear power plants by performing independent safety research. The Federal Ministry of Economics and Technology (BMWi) currently provides approximately € 20 million annually for reactor safety research. This research deals, among others, with experimental or analytical studies on the plant behaviour of light water reactors under accident conditions, on non-destructive early detection of damage for materials difficult to inspect, on the safety of pressure retaining components, on core meltdown and on human factors, as well as the development of probabilistic safety analysis methods.

In the field of nuclear safety and waste management research of the Federal Ministry of Education and Research (BMBF), a funding initiative is underway that comprises the particularly fundamental work on safety research for core reactors and on nuclear waste disposal. The particular aim is to support the promotion of junior scientists at universities in order to counteract a loss of competence in nuclear technology in Germany with regard to national and international requirements. This promotion of junior staff in the field of nuclear safety research by the BMBF is realised with € 10 million per year. For fusion research, a total of about € 142 million were provided in 2009 within the framework of institutional and project funding.

The plant operators also give top priority to research and development in the field of nuclear safety. This circumstance is reflected, among others, in the budget of the ad-hoc committee on systems engineering ("Sonderausschuss Anlagentechnik") used by the plant operators to fund joint research and development projects under the umbrella of the VGB. Currently, about 130 projects are underway. About 70 to 90 new projects start per year. These projects are financed with a budget of about € 9 million per year. Focal points are, among others,

- materials science,
- systems and component engineering,
- accident analysis,
- non-destructive tests,
- PSA,
- fuel behaviour,
- radiation protection,
- issue of hydrogen, and
- seismic qualification.

Activities of the BMU

In fulfilling its statutory duties for the safe use of nuclear energy, the BMU has to clarify questions of fundamental importance for the safety of nuclear installations (→ Article 8).

Installation for which decisions on shutdown have been made

No nuclear power plants were shut down in terms of Article 6.

Position of the Federal Republic of Germany concerning the safety of the nuclear power plants in Germany

As noted in the policy statement by Federal Chancellor Merkel of 10 November 2009, the Federal Government focuses on an energy mix which gradually replaces the conventional sources of energy by renewable energies. For a transitional period, nuclear energy will remain an indispensable part of the energy mix as a bridge technology. The Federal Government is therefore prepared to extend the operating lives of the German nuclear power plants in compliance with the rigorous German and international safety standards and to use a substantial part of the additional profits of the power plant operators to accelerate the way into the age of regenerative energy, for example through increased research on energy efficiency and on the storage technologies.

The Federal Government is expressly committed to further demand and enforces the high level of nuclear safety of the German nuclear power plants. This report includes, among others, on the one hand, presentations regarding the existing regulatory requirements and potential developments in this respect and, on the other hand, presentations regarding important measures implemented or planned since the last report.

Central elements are the responsibility of the operator and a comprehensive supervision by the competent authorities.

In summary, the Federal Government ascertains that the Federal Republic of Germany fulfils the obligations under the Convention on Nuclear Safety.

Article 6: Progress and changes since 2007

Besides the permanent supervision of the nuclear power plants, the additional safety reviews (SRs) required by law (→ Section19a of the Atomic Energy Action) had been conducted since 2007 for the nuclear power plants Neckarwestheim-1, Gundremmingen-B, Gundremmingen-C, Grafenrheinfeld, Krümmel, Philippsburg-2, Isar-2, Emsland and Neckarwestheim-2. For the plants Grohnde and Biblis B, completion is scheduled for the end of 2010.

Article 6: Future activities

The safety assessments are continued as it is common practice within the framework of licensing and supervision, including the additional safety reviews (SRs) required by law.

7 Legislative and regulatory framework

ARTICLE 7 LEGISLATIVE AND REGULATORY FRAMEWORK

1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.
2. The legislative and regulatory framework shall provide for:
   i) the establishment of applicable national safety requirements and regulations;
   ii) a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a licence:
   iii) a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licences;
   iv) the enforcement of applicable regulations and of the terms of licences, including suspension, modification or revocation.

7 (1) Legislative and regulatory framework

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

The Republic of Germany is a federal state. The responsibilities for legislation and law enforcement are assigned to the organs of the Federation and the *Länder* according to their scope of functions. Specifications are given by provisions of the Basic Law [1A-1] of the Federal Republic of Germany.

The Federal Government has the legislative competence for the use of nuclear energy for peaceful purposes according to Article 73 para 1 number 14 in conjunction with Article 71 of the Basic Law. Further development of the nuclear law also lies within the responsibility of the Federation. The *Länder* are involved in the procedure.

According to Section 24 para 1 of the Atomic Energy Act in conjunction with Article 87c, 85 of the Basic Law, the Atomic Energy Act [1A-3] and the statutory ordinances based thereon are executed - with some exceptions - by the *Länder* on behalf of the Federation. In this respect, the *Länder* authorities are under the oversight of the Federation with regard to the legality and expediency of their actions.

> ***Article 85***
> ***[Execution by the Länder on federal commission]***
>
> ***(1)*** *Where the Länder execute federal laws on federal commission, establishment of the authorities shall remain the concern of the Länder, except insofar as federal laws enacted with the consent of the Bundesrat otherwise provide. Federal laws may not entrust municipalities and associations of municipalities with any tasks.*
>
> ***(2)*** *The Federal Government, with the consent of the Bundesrat, may issue general administrative rules. It may provide for the uniform training of civil servants and other salaried public employees. The heads of intermediate authorities shall be appointed with its approval.*

> ***(3)** The Land authorities shall be subject to instructions from the competent highest federal authorities. Such instructions shall be addressed to the highest Land authorities unless the Federal Government considers the matter urgent. Implementation of the instructions shall be ensured by the highest Land authorities.*
>
> ***(4)** Federal oversight shall extend to the legality and appropriateness of execution. For this purpose the Federal Government may require the submission of reports and documents and send commissioners to all authorities.*

The competent supervisory and licensing authorities report to the Federation on law enforcement on demand. The Federation has the right to require the submission of reports and documents and may, in the individual case, issue binding directives to the *Land* authority. The Federation may assume the competence for the subject matter, i.e. the decision in the cause, by exercising its right to issue directives. The competence to execute the duties, i.e. the execution of the decision towards the applicant or licensee, remains with the competent *Land* authority.

Within the framework of nuclear procedures, other legal regulations, such as the immission control act, water law and construction law, also have to be considered. Legal regulations on assessing the environmental impact are usually part of the nuclear licensing procedure.

In Germany, decisions of the public administration, so-called administrative acts, can be appealed before the administrative courts by the party concerned, e.g. by applicants and licensees and also by third parties of the public concerned (guarantee of recourse to the courts according to Article 19 para 4 of the Basic Law). An action is brought against that authority which issued the notice/administrative act, i.e. the respective competent *Land* authority. This also applies to the case that the *Land* took a decision due to a directive issued by the Federation. The parties concerned may also take legal actions in case of failure of the authorities to act. So, e.g., the plant operators may claim for granting of licences applied for or the residents for issuance of a regulatory order to cease operation of a nuclear installation.

Involvement of international and European law

<u>International treaties</u>

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

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

An overview of the most important international treaties of the Federal Republic of Germany in the fields of nuclear safety, radiation protection and liability, and to national implementing provisions is to be found in Appendix 5 [1E].

For Germany, the Convention on Nuclear Safety [1E-2.1] entered into force on 20 April 1997.

<u>Legal provisions of the European Union</u>

In Germany, legislation and administrative work must take into account any binding requirement from regulations of the European Union. An overview of the legal provisions of the European Union, in particular in the field of radiation protection, is to be found in Appendix 5 [1F].

In accordance with Article 77 et seq. of the EAEC Treaty, any utilisation of ores, source material and special fissile material is subject to surveillance by the European Atomic Energy Community.

In the field of radiation protection, the EURATOM Basic Safety Standards for the protection of the health of the general public and workers against the dangers arising from ionising radiation were issued on the basis of Article 30 et seq. (health protection) of the EAEC Treaty [1F-2.1].

Council Directive 96/29/EURATOM, laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation [1F-2.1], of 1996 was also transposed into national law by the Radiation Protection Ordinance [1A-8].

On 22 July 2009, Council Directive 2009/71/EURATOM establishing a Community framework for the nuclear safety of nuclear installations [1F-1.25] entered into force to supplement the directives of the European Atomic Energy Community on radiation protection. Thus, for the first time, legally binding European rules on nuclear safety had been established. The objective of the Directive is to maintain and promote the continuous improvement of nuclear safety. The member states are to provide for appropriate national arrangements to effectively protect workers and the general public against the dangers arising from ionising radiation from nuclear installations. The Directive applies, among others, to nuclear power plants, research reactors and interim storage facilities but not to repositories for radioactive waste. The Directive includes provisions regarding the establishment of a legislative and regulatory framework for nuclear safety, the organisation and tasks of the nuclear authorities, the obligations of the operators of nuclear installations, the education and training of the staff of all parties involved, and on information to the public.

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

Council Directive 2009/71/EURATOM is to be transposed into national law by 22 July 2011, two years after its entering into force. These Directive contents are partly covered by the existing German law. For full transposition, adaptation of the nuclear law is being prepared.

As regards contents, Article 4 of Council Directive 2009/71/EURATOM establishing a Community framework for the nuclear safety of nuclear installations [1F-1.25] (legislative, regulatory and organisational framework) falls into the scope of Article 7 of the Convention on Nuclear Safety.

7 (2) (i) Nuclear safety regulations

National nuclear safety regulations

Figure 7-1 presents the hierarchy of the national regulations, the authority or institution issuing them and their degree of bindingness.

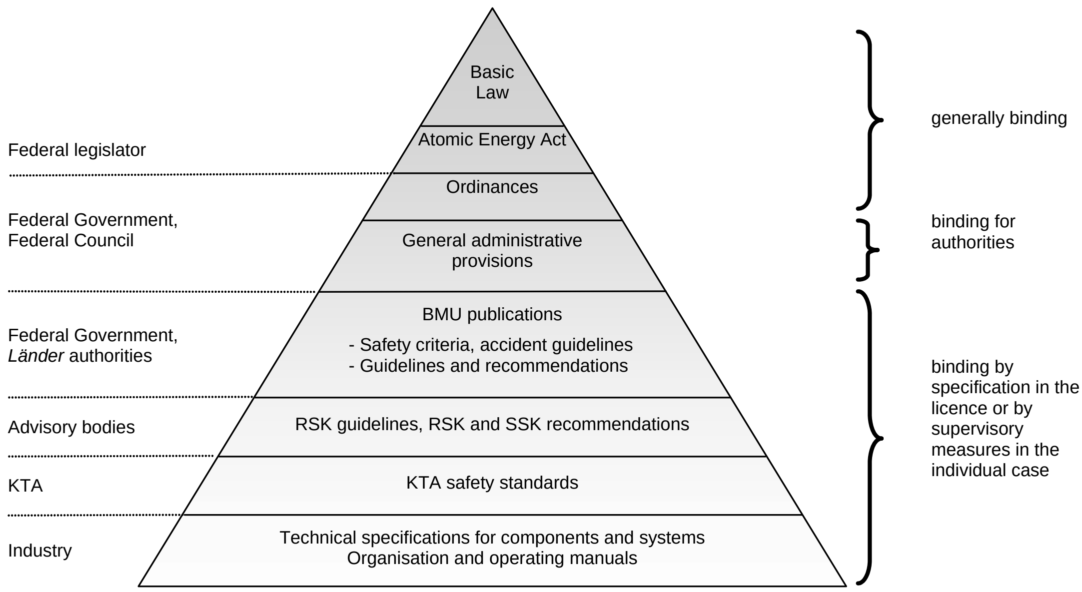


Figure 7-1 Regulatory pyramid

<u>Acts, ordinances and administrative provisions</u>

Basic Law

The Basic Law [1A-1] includes provisions on the legislative and administrative competencies of the Federation and the *Länder* regarding the use of nuclear energy. (An overview of the assignment of regulatory functions to the nuclear authorities of the Federation and the *Länder* is given in the reporting relating to Article 8). Moreover, fundamental principles are established that are also applicable to the nuclear law.

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

Formal federal law, in particular the Atomic Energy Act

The Atomic Energy Act [1A-3] was promulgated on December 23, 1959, right after the Federal Republic of Germany had officially renounced any use of atomic weapons. Since then, it has been amended several times. The purpose of the Atomic Energy Act after the amendment of 2002 is to end the use of nuclear energy for the commercial production of electricity in a structured manner and to ensure on-going operation until the date of discontinuation, 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 has the purpose of preventing the internal or external security of the Federal Republic of Germany from being endangered by the utilisation of nuclear energy. Another purpose of the Atomic Energy Act is to ensure that the Federal Republic of Germany meets its international obligations in the field of nuclear energy and radiation protection.

The Atomic Energy Act includes the general national regulations for protective and preventive measures, radiation protection and the disposal of radioactive waste and irradiated fuel elements in Germany and is the basis for the associated ordinances.

Further to purpose and general provisions, the Atomic Energy Act also comprises surveillance regulations, general regulations on competencies of the administrative authorities, liability provisions and provisions on the payment of fines.

With respect to the protection against the hazards from radioactive materials and to the supervision of their utilisation, the Atomic Energy Act requires that the construction and operation of nuclear installations is subject to regulatory licensing. Prerequisites and procedures for licensing and performance of supervision are specified, including the regulations for consulting experts (Section 20 of the Atomic Energy Act) and charging of costs (Section 21 of the Atomic Energy Act).

However, most of the regulations laid down there are not exhaustive and are further specified both regarding the procedures and the substantive legal requirements by ordinances and regulatory guidance instruments.

According to Section 7 of the Atomic Energy Act, a licence is required for the construction, operation or any other holding of a stationary installation for the production, treatment, processing or fission of nuclear fuel, or for essentially modifying such installation or its operation.

Such a licence may only be granted if the licensing prerequisites stated in Section 7 para 2 of the Atomic Energy Act are fulfilled, i.e. if

- the necessary precautions against damage have been taken in the light of the state of the art in science and technology (number 3),
- trustworthiness and technical qualification of the responsible personnel is given (number 1),
- it is assured that the persons who are otherwise engaged in the operation of the installation have the necessary knowledge concerning the safe operation of the installation, the possible hazards and the protective measures to be taken (number 2),
- the necessary protection has been provided against disruptive action or other interference by third parties (number 5),
- the necessary financial security has been provided to comply with the legal liability to pay compensation for damage (number 4), and
- the choice of the site of the installation does not conflict with overriding public interests, in particular in view of its environmental impacts (number 6).

Today, these requirements are only relevant as licensing prerequisite for modifications or the decommissioning of existing plants, since Section 7 para 1 sentence 2 of the Atomic Energy Act stipulates that no further licences will be issued for the construction and operation of nuclear power plants and reprocessing facilities.

For transposition of the Council Directive 2009/71/EURATOM establishing a Community framework for the nuclear safety of nuclear installations [1F-1.25], adaptation of the nuclear law is being prepared.

In addition to the Atomic Energy Act, the Radiation Precautionary Act [1A-5] of 1986, which came about in the wake of the reactor accident at Chernobyl, specifies the tasks of environmental monitoring also in the case of events with significant radiological effects.

Another legal basis to be mentioned is the "Act on the Establishment of a Federal Office for Radiation Protection" [1A-2.3] by which certain tasks regarding the safety of nuclear power plants are delegated to this office to support the nuclear federal authorities.

Ordinances

For more details regarding the legal regulations, the Atomic Energy Act includes authorisations for issuing ordinances (cf. listing in Section 54 para 1 of the Atomic Energy Act). These ordinances require approval by the *Bundesrat* (Federal Council). The *Bundesrat* is a constitutional body of the Federation in which the governments of the *Länder* are represented.

Table 7-1 presents the current ordinances on protective and preventive measures.

Table 7-1 Ordinances on protective and preventive measures at nuclear power plants

	Brief description on the legislative content	[Ref.]
StrlSchV	**Radiation Protection Ordinance** Principles and limits of radiation protection, requirements on organisation of radiation protection, personal monitoring, environmental monitoring, accident management, design against incidents and accident planning values	1A-08
AtVfV	**Nuclear Licensing Procedure Ordinance** Application documents (one safety analysis report), involvement of the public, safety specifications (operational limits and conditions for safe operation), procedures and criteria for major modifications (public participation)	1A-10
AtSMV	**Nuclear Safety Officer and Reporting Ordinance** Position, duties, responsibilities of the nuclear safety officer, reporting of special events in nuclear installations	1A-17
AtZüV	**Nuclear Reliability Assessment Ordinance** Checking of personal reliability for protecting against the diversion or major release of radioactive material	1A-19
AtDeckV	**Nuclear Financial Security Ordinance** Financial security pursuant to the Atomic Energy Act	1A-11
AtKostV	**Cost Ordinance under the Atomic Energy Act** Fees and costs in nuclear procedures	1A-21
KIV	**Ordinance Concerning Potassium Iodide Tablets** Provision and distribution of medicine containing potassium iodide as thyroid blocker in case of radiological events	1A-20
AtAV	**Nuclear Waste Transfer Ordinance** Transfer of radioactive wastes into or out of the territory of the Federal Republic of Germany	1A-18
Endlager VlV	**Repository Prepayment Ordinance** Advance payments for the construction of radioactive waste disposal facilities of the Federation for the long-term engineered storage and disposal of radioactive waste	1A-13

General administrative provisions

Ordinances may include additional authorisations for issuing general administrative provisions. General administrative provisions regulate the actions of the authorities, thus only having a direct binding effect for the administration. However, they have an indirect effect if serving as a basis for concrete administrative decisions.

In the nuclear sector, there are six general administrative provisions [2] relevant to

- the calculation of radiation exposure during specified normal operation of nuclear power plants [2-1],
- the radiation passport [2-2],
- the environmental impact assessment [2-3]
- the environmental monitoring [2-4], and
- the monitoring of foodstuffs and feedingstuffs [2-5], [2-6].

<u>Regulatory guidelines published by BMU</u>

After having consulted the *Länder*, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) prepares regulatory guidelines. These are, among others, safety criteria, accident and other guidelines and recommendations. In general, these are regulations passed in consensus with the competent licensing and supervisory authorities of the *Länder* on the uniform application of the Atomic Energy Act. The recommendations of the BMU, however, describe its view on general questions related to nuclear safety and the administrative practice, and serve as orientation for the *Länder* authorities regarding the enforcement of the Atomic Energy Act. The regulatory guidelines are not binding for the *Länder* authorities in contrast to the general administrative provisions. Their relevance is also given by the right of the BMU to issue binding individual directives for particular cases to the *Länder* authorities.

Currently, about 60 BMU regulatory guidelines exist in the field of nuclear technology (→ Appendix 5 under “3 Regulatory Guidelines Published by BMU and the Formerly Competent Ministry of the Interior“[3]). These are regulations pertaining to

- general safety requirements for nuclear power plants (”Safety Criteria”),
- details on the design basis accidents to be considered in the design of pressurised water reactors (since 1982 for the last three nuclear power plants built of construction line 4),
- dispersion calculations,
- accident management measures to be planned by the plant operators with regard to postulated severe accidents,
- measures regarding disaster control in the vicinity of nuclear installations,
- measures against disruptive action or other interference by third parties,
- radiation protection during maintenance work,
- reporting criteria for reportable events at nuclear power plants and research reactors,
- monitoring of emissions and radioactivity in the environment,
- periodic safety reviews for nuclear power plants,
- technical documents to be prepared regarding construction, operation and decommissioning of nuclear power plants,
- documents to be supplied with the application for a licence,

- procedures for the preparation and performance of maintenance and modification work in nuclear power plants, and
- qualification of the personnel in nuclear installations.

Other regulatory guidance instruments on the safety of nuclear power plants

Recommendations of the RSK or the SSK; RSK guidelines

The BMU requests the Reactor Safety Commission (RSK) and the Commission on Radiological Protection (SSK) for advice on important issues related to licensing and supervisory procedures, development of rules and regulations or safety research. In addition, the commissions may also give advice on their own initiative. Depending on the issues to be discussed, *Länder* authorities, plant operators or the industry also participate in the discussions. The results of these discussions are statements or recommendations for the BMU. After own verification, the BMU implements the results in the respectively appropriate manner.

The so-called RSK guidelines [4-1] play a special role. In the last version of these guidelines of 1996, the RSK compiled the fundamental safety requirements for nuclear power plants with pressurised water reactors. The RSK uses these guidelines as a basis of its advisory work and recommendations. The RSK deviates from them if the state of the art in science and technology has meanwhile changed in specific areas.

The nuclear licensing authorities of the *Länder* have taken the RSK guidelines as an assessment basis within the framework of the regulatory guidance instruments for plants whose licences on the site and safety concept were to be granted after entry into force of the RSK guideline and made them binding for the plant operator by the licence permit. For plants that were granted a licence before, the RSK guidelines were referred to for assessing the adequacy of the further development of plant safety.

KTA safety standards

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

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

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

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

Historically, the KTA safety standards have been developed on the basis of applicable German technical standards and regulations and on the American nuclear safety standards. The ASME-Code (Section III) was used as a model for specifying the requirements regarding the design and construction of components.

The KTA safety standards pertain to

- organisational issues,
- industrial safety (specific additional requirements within the field of nuclear technology),
- civil engineering,
- nuclear and thermal-hydraulic design,
- issues regarding materials,
- instrumentation and control,
- monitoring of radioactivity, and
- other provisions.

Special focus is placed on quality assurance and quality management; this aspect is addressed in most of the safety standards. The term quality assurance as used in the KTA safety standards also comprises the area of ageing which, today, is internationally treated as a separate issue.

On the basis of the regular reviews and, where required, amendment of the issued safety standards at intervals of no more than five years, the standards are adjusted to the state of the art in science and technology. In themselves, KTA safety standards are not legally binding. However, due to the nature of their origin and their high degree of detail, they have a far-reaching practical effect.

Until today, the KTA has issued a total of 91 safety standards and 3 draft standards. 12 draft standards are in preparation and 50 safety standards are in the process of being revised.

Within the framework of the KTA work, the following draft safety standards have been in preparation in the last years:

- [KTA 1203] "Requirements for the Emergency Manual“,
- [KTA 1402] “Management Systems for the Operation of Nuclear Facilities",
- [KTA 1403] “Ageing Management in Nuclear Power Plants",
- [KTA 3107] “Criticality Safety in Light Water Reactors during Refuelling“,
- [KTA 3206] “Demonstration of Break Preclusion for Pressure Retaining Components in Nuclear Power Plants“

Conventional technical standards

For the construction and operation of nuclear installations, conventional technical rules apply subsidiary. This is particularly the case for the national standards of the German Institute for Standardisation (DIN) and the international standards of ISO and IEC.

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

Revision of the nuclear rules and regulations

National nuclear rules and regulations

The applicable national higher-level nuclear rules and regulations date back to the 1970s and 1980s. In science and practice there is consensus that the modernisation and further development of the higher-level nuclear rules and regulations is necessary. This view is also shared by the Federation and the *Länder*.

The drafting process for the development of the new rules and regulations started in September 2003.

With the new *Safety Criteria for Nuclear Power Plants*, the draft [3-0] of a new higher-level nuclear rules and regulations is now available. The Federal Ministry for the Environment published the draft of the new “Safety Criteria for Nuclear Power Plants - Revision D, of April 2009” on the Internet.

The new Safety Criteria are to ensure the integration of existing rules, current practice, international requirements and new scientific findings, and to replace the *Safety Criteria for Nuclear Power Plants, as of 1977* [3-1], the *RSK guidelines for pressurised water reactors* [4-1], as of 1981 with updates of 1996, and the *accident guidelines* [3-33] of 1983.

Against this background, the Federal Ministry for the Environment and the *Länder* of Baden-Wuerttemberg, Bavaria, Hesse, Lower Saxony and Schleswig-Holstein have agreed upon a comprehensive consultation procedure for further action with the *Länder*, power utilities and science.

The agreed procedure aims to contribute to gain practical experience in the application of the new Safety Criteria and evaluate it in a process agreed between the Federation and the *Länder* (see below). The test phase started on 1 July 2009 and will and on 31 October 2010. On this basis of practical experience gained from testing, the Federation and the *Länder* jointly review the rules and regulations by mid-2011. The Federation and the *Länder* are striving for a unanimous adoption of the nuclear rules and regulations. Publication by the Federal Ministry for the Environment in the Federal Gazette will not take place before the end of the procedure.

The Federation and the *Länder* will apply the new Safety Criteria for Nuclear Power Plants [3-0] on a trial basis and in parallel to the higher-level rules and regulations relevant so far in nuclear procedures. This application takes place in nuclear licensing procedures and modifications procedures requiring approval (including PSR, reportable events and hazard assessment) in order to gain experience with the application of all modules. In this respect, all modules of the draft of the new Safety Criteria relevant for the procedures to be selected are applied:

- MODULE 1 “Safety Criteria for Nuclear Power Plants:
  Fundamental Safety Criteria“;
- MODULE 2 “Safety Criteria for Nuclear Power Plants:
  Criteria for the Design and Operation of the Reactor Core“;

- MODULE 3 “Safety Criteria for Nuclear Power Plants: Events to be Considered for Pressurised and Boiling Water Reactors“;
- MODULE 4 “Safety Criteria for Nuclear Power Plants: Criteria for the Design of the Reactor Coolant Pressure Boundary, the Pressure Retaining Walls of the External Systems and the Containment System“;
- MODULE 5 “Safety Criteria for Nuclear Power Plants: Criteria for Instrumentation and Control and Accident Instrumentation“;
- MODULE 6 “Safety Criteria for Nuclear Power Plants: Criteria for Safety Demonstration and Documentation“;
- MODULE 7 “Safety Criteria for Nuclear Power Plants: Criteria for Accident Management“;
- MODULE 8 “Safety Criteria for Nuclear Power Plants: Criteria for Safety Management“;
- MODULE 9 “Safety Criteria for Nuclear Power Plants: Criteria for Radiation Protection“;
- MODULE 10 “Safety Criteria for Nuclear Power Plants: Criteria for the Design and Safe Operation of Plant Structures, Systems and Components“;
- MODULE 11 “Safety Criteria for Nuclear Power Plants: Criteria for the Handling and Storage of the Fuel Elements“;
- MODULE 12 “Safety Criteria for Nuclear Power Plants: Criteria for Electric Power Supply“

Development of international rules and regulations

Technical experts from Germany participate in the international development of nuclear rules and regulations. On the one hand, the aim is to reach best possible precaution against damage and to effect an advancement of the national rules and regulations with the help and support of the international nuclear rules and regulations. On the other hand, these international developments are to make a contribution to European harmonisation.

In this respect, several projects were performed within the reporting period:

- Analysis of the nuclear rules and regulations in connection with the development and setting up of the WENRA reference levels (WENRA RL).
- As a basis for developing and setting up the 295 WENRA RL, the relevant safety standards of the International Atomic Energy Agency (IAEA) were evaluated. As a result of this work, a direct comparison for each of the 18 WENRA issues with current German regulations and IAEA rules and regulations was performed. The results are used for the development of the German WENRA Action Plan and for the work for update of the German nuclear rules and regulations.
- Comparison of the German rules and regulations with current IAEA safety standards.
- Participation in the development and revision of IAEA rules and regulations and in safety standards commissions and committees such as CSS and NUSSC.
- Germany participates in the development and revision of different IAEA safety standards by sending technical experts from organisations of different.

- The BMU is represented in the CSS and in the NUSSC. It has been practice for many years, to formally involve the public before IAEA rules and regulations are passed: for this purpose, the drafts are published in the Federal Bulletin with the request for comments.
- In 2006, the BMU started to prepare annual summary reports on the work of the IAEA on rules and regulations. These reports are submitted to the nuclear authorities and their experts and are also made public. These reports serve the systematic information of the German authorities and their experts on the work carried out by the IAEA and, at the same time, provide the discussion basis for implementation of progress of the IAEA rules and regulations work into the German safety practice.

<u>Action plan for adaptation of the rules and regulations and safety practice to the WENRA reference levels</u>

By the end of 2006, WENRA developed 295 reference levels based on the IAEA safety standards relating to 18 issues. The issues cover the areas in which a great need for harmonisation in Europe has been identified. The WENRA Reactor Harmonisation Working Group (RHWG) examined where in the national rules and regulations of the WENRA countries are gaps compared to the reference levels ("benchmark procedure"). Germany, like the other WENRA countries, drew up an Action Plan to fill existing gaps. The new "Safety Criteria for Nuclear Power Plants" are intended to be an element of Germany to fill existing gaps in the nuclear rules and regulations. The respective national action plans are now being reviewed by the WENRA RHWG. The review is due to be completed in 2011. To this end, a plan for adaptation is to be developed by the BMU and the nuclear supervisory authorities of the *Länder*.

7 (2) (ii) System of licensing

General provisions

The licensing of nuclear installations is regulated in the Atomic Energy Act [1A-3]. According to Section 7 of this Act, certain facilities (in particular, nuclear power plants) require a licence for the construction, operation, essential modifications of the plant or its operation and also for decommissioning. When issuing a licence, obligations may generally be imposed for achieving the purpose of protection. Any act of operating, otherwise holding, essentially modifying or decommissioning a nuclear installation without the required corresponding licence permit is punishable by law (Section 327 of the Penal Code) [1B-11].

According to the applicable law (amendment of the Atomic Energy Act of 2002), licences for the construction of nuclear power plants for the commercial production of electricity are no longer issued (Section 7 para 1 sentence 2 of the Atomic Energy Act). The licences for operation of the existing nuclear power plants are not limited in time and thus do not require a renewal. The authorisation for power operation of the existing nuclear power plants expires once the electricity volume for the respective plant as stipulated in the Atomic Energy Act or the electricity volume derived from transfers has been produced (Section 7 para 1a of the Atomic Energy Act). Therefore, licensing procedures are only performed for the modification of existing nuclear installations and for decommissioning.

Thus, the following presentation concentrates on licensing procedures for major modifications of the existing nuclear power plants or their operation. Decommissioning of nuclear power plants is object of reporting within the framework of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [1E-3.2].

The planned modifications of a nuclear power plant or its operation are to be assessed systematically with regard to their impacts on the necessary protective and preventive measures and are to be treated in the procedure accordingly. Modifications that may have greater than obviously insignificant impacts on the safety level of the nuclear installations are subject to licensing pursuant to Section 7 para 1 of the Atomic Energy Act. For modifications requiring a licence, the fulfilment of the licensing prerequisites is to be verified according to Section 7 of the Atomic Energy Act. In addition, there are modifications obviously having only insignificant impacts on the safety level and therefore are not subject to licensing but require accompanying inspections by the safety authorities within the framework of the supervisory procedure.

The actual details and procedure of licensing according to the Atomic Energy Act are specified in the Nuclear Licensing Procedure Ordinance [1A-10]. It deals specifically with the application procedure, with the submittal of supporting documents, with the participation of the general public and with the possibility to split the procedure into several licensing steps (partial licences). It deals, furthermore, with the assessment of environmental impacts [1F-1.15; 1B-3] and with the consideration of other licensing requirements (e.g. regarding the possible release or discharge of non-radioactive pollutants into air or water (→ Article 17 (ii)).

The Paris Convention on Third Party Liability in the Field of Nuclear Energy [1E-5.1] and the Joint Protocol [1E-5.4] have been implemented into national nuclear liability legislation with direct applicability (self-executing) and are supplemented by it. For damages due to a nuclear event caused by a nuclear installation, the operator generally has unlimited liability. In order to fulfil the obligation to pay any damages, the operator has to provide financial security which may amount, according to the Atomic Energy Act as amended in 2002, to 2.5 billion Euros; details on this issue are regulated by the Nuclear Financial Security Ordinance [1A-11]. Financial security may be ensured by liability insurance or other financial means, e.g. private warranty. Where the legal liability to pay damages is not covered by the financial security provided or cannot be fulfilled with it, the Atomic Energy Act grants the operator the right against the Federal Government and the *Land* issuing the licence to be exempted from this liability to pay damages. The maximum indemnity carried by the Federal Government amounts to 2.5 billion Euros.

Details of the nuclear licensing procedure

Licence application

The written licence application is submitted to the competent licensing authority of that *Land* in which the nuclear installation is sited. Along with the application, the applicant has to submit documents required for the examination of the licensing prerequisites by the licensing authority and the experts consulted by the authority. These documents are stated in Sections 2, 3 of the Nuclear Licensing Procedure Ordinance [1A-10] and further specified in guidelines.

In case of applications for modification licences, the examination of the licensing prerequisites does not only refer to the object of modification where major modifications are concerned but also to those plant components and procedural steps of the licensed plant on which the modification will have an impact. The documents have to cover these plant components and procedural steps. In order to verify that the licensing prerequisites are fulfilled, appropriate documents are to be submitted on the issues concerned by the modification.

Examination of the application

On the basis of the submitted documents, the licensing authority examines whether or not the licensing prerequisites have been met. All federal, *Länder*, local and other regional authorities – according to circumstances also authorities of other states (Section 7a of the Nuclear Licensing Procedure Ordinance) - whose jurisdiction is involved shall take part in the licensing procedure. These are, e.g. - depending on the object of licensing - authorities responsible under the building code, the water code, for regional planning and for disaster control. Due to the large 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 review of the application documents. In their expert analysis reports they explain whether or not the requirements regarding nuclear safety and radiation protection have been met. They have no autonomous decision-making powers. The licensing authority assesses and decides on the basis of its own judgment. The authority is not bound by the findings of their authorised experts. Further information relating to the German system of review assessment is given in Chapter 8.

Within the frame of federal executive administration, the licensing authority of the individual *Land* informs the Federal Ministry for the Environment if it deems the licensing procedure to be significant, if criteria generally defined by the Federal Ministry for the Environment are fulfilled (e.g. power increase, introduction of digital I&C in safety systems, shortening of test intervals) or if the Federal Ministry for the Environment regards the involvement of the Federation as necessary in the individual case. In performing these functions, the Federal Ministry for the Environment consults its advisory commissions, the RSK and the SSK, and in many cases the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) for advice and technical support and, where required, states its position on the draft decision to the competent *Land* authority.

Participation of the general public

Public participation shall offer the citizens the opportunity to bring in their interests directly into the procedure. Participation of the public was obligatory for construction licences. In case of major modifications, the authority may waive a public participation according to the Nuclear Licensing Procedure Ordinance if the modification does not give rise to concern that there may be adverse effects on the public. However, the public has to be involved if this is required pursuant to the Act on the Assessment of Environmental Impacts.

The Nuclear Licensing Procedure Ordinance [1A-10] includes regulations

- on the conditions under which the licensing authority may waive a public participation or must involve the public,
- on the public announcement of the project and public disclosure of the application documents at a suitable location near the site for a period of two months, including the request for raising any objections within the presentation period (Sections 4-7a of the Nuclear Licensing Procedure Ordinance),
- on the holding of a public hearing where the objections are discussed between licensing authority, licence applicant and the persons who have raised the objections (Sections 8-13 of the Nuclear Licensing Procedure Ordinance).

The licensing authority acknowledges all of the objections in its decision making process and states the reasons for the decision.

If the licensing procedure is conducted with public participation, the applicant shall submit a brief, readily understandable description of the installation and the alteration applied for for informing the public in addition to the application documents to be submitted in all licensing procedures for examination of the licensing prerequisites by the licensing authority and the (Section 6 para 1 (3) in conjunction with Section 3 para 4 of the Nuclear Licensing Procedure Ordinance). Moreover, the applicant shall prepare a safety report (Section 6 para 1 (2) in conjunction with Section 3 para 1 (1) of the Nuclear Licensing Procedure Ordinance) that is reviewed by the competent authority with the support of authorised experts in the course of the licensing process. It mainly serves to describe effects related to the modification, including the possibly changed effects of design basis accidents and the associated precautionary measures such that the citizens that might be affected can judge whether their rights are being violated. This report is not a “safety analysis report” for the determination and update of the licensing status.

Environmental impact assessment

The Act on the Assessment of Environmental Impacts [1F-1.15] in conjunction with Section 2a of the Atomic Energy Act [1A-3] and provisions of the Nuclear Licensing Procedure Ordinance [1A-10] based on the Atomic Energy Act specify the requirement for an environmental impact assessment and its procedure within the nuclear licensing procedure for the construction, operation and decommissioning of a nuclear power plant or for an essential modification of the plant or its operation. The competent authority performs a final evaluation of the environmental impacts on the basis of the requirements in nuclear and radiation protection regulations. This final evaluation is the basis for the decision about the permissibility of the project with regard to achieving an 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 and, if available, the statement by the BMU and the authorities involved as well as the findings from objections raised in the public hearing. Prerequisite for the legality of this decision is that all procedural requirements of the Nuclear Licensing Procedure Ordinance are fulfilled. Action can be brought against the decision of the licensing authority before the administrative courts.

The Atomic Energy Act includes the necessary authorisation providing the basis for the supervisory authorities of the *Länder* to proceed against an unlicensed construction or an unlicensed operation of a nuclear installation. In particular, the licensing authority is empowered to temporarily prohibit an unlicensed construction or mode of operation by an immediately enforceable order of discontinuance or to order final cessation of operation if a required licence had not been granted by the licensing authority or the required licence had been revoked. The licensing authority does not only have these powers in cases in which a nuclear installation is operated without any licence, but also if the installation has been constructed or is operated materially differently from the licences granted.

7 (2) (iii) Regulatory inspection and assessment (supervision)

Over their entire lifetime - from the start of construction to the end of decommissioning with the corresponding licences - nuclear installations are subject to continuous regulatory supervision in accordance with the Atomic Energy Act and accessory nuclear ordinances. Supervision is performed by the *Länder* authorities. The *Länder* act on behalf of the Federal Government also with regard to the supervisory procedure (→ Article 7 (1)), i.e. the Federal Government again has the right to issue binding directives on factual and legal issues in each individual case. Just as in the licensing procedure, the *Länder* are assisted by independent authorised experts. The decisions on supervisory measures to be performed are taken by the supervisory authority.

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

The supervisory authority pays particular attention to

- the fulfilment of the provisions, obligations and ancillary provisions imposed by the licence notices,
- the fulfilment of the requirements of the Atomic Energy Act, the nuclear ordinances and the other nuclear safety standards and guidelines, and
- the fulfilment of any supervisory order.

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

- the compliance with the operating procedures,
- the performance of in-service inspections of components and systems important to safety,
- the evaluation of reportable events,
- the implementation of modifications of the nuclear installation or its operation,
- the radiation protection monitoring of the nuclear power plant personnel,
- the radiation protection monitoring in the vicinity of the nuclear installation, including the operation of the independent authority-owned remote monitoring system for nuclear reactors,
- the compliance with the authorised limits for radioactive discharge,
- the measures taken against disruptive action or other interference by third parties,
- the trustworthiness and technical qualification and the maintenance of the qualification of the responsible persons as well as of the knowledge of the otherwise engaged personnel in the installation, and
- the quality assurance measures.

In accordance with the Atomic Energy Act, the authorised experts called in by the supervisory authority have access to the nuclear installation at any time and are authorised to perform necessary examinations and to demand pertinent information (Section 20 in conjunction with Section 19 para 2 of the Atomic Energy Act [1A-3]). The supervisory authority is not bound by the result of their examinations.

The operators of nuclear power plants have to supply written operating reports to the supervisory authorities at regular intervals. These include data on the operating history, on maintenance measures and inspections, on radiation protection and on radioactive waste material. Any events that are relevant to safety and to physical protection must be reported to the authorities according to the provisions specified in the Nuclear Safety Officer and Reporting Ordinance (AtSMV) [1A-17]. The regulations and procedures regarding reportable events and their evaluation are described under Article 19 (vi) - (vii). In addition, the plant operators regularly report on specific issues.

In addition to the continuous regulatory supervision, comprehensive periodic safety reviews are performed every ten years. Since 2002, the obligations to conduct the safety reviews and to submit the results on specified dates have also been regulated by law in Section 19a of the Atomic Energy Act (→ Article 14 (i)).

On-site supervisory activities of the supervisory authority during normal operation are performed, on average, once per week and plant.

The experts consulted even show greater presence. The involvement of the different management levels of the plant operators is always ensured. During plant revisions with refuelling outages and after reportable events, on-site supervision also takes place every working day.

7 (2) (iv) Enforcement of regulations and provisions

Enforcement by regulatory order, particularly in urgent cases

According to Section 19 of the Atomic Energy Act, the supervisory authority may order that the operator discontinues a situation which is contrary to the provisions of the Atomic Energy Act, the nuclear statutory ordinances, the terms and conditions of the licence or to any subsequently imposed obligation, or which may constitute a hazard to life, health or property. Depending on the specific circumstances of the individual case, it may, in particular, order that

- certain protective measures are taken,
- that operation may only be continued with restrictions or subject to certain conditions, or
- operation is to be discontinued temporarily until the causes of an event are clarified and necessary remedial actions against recurrence are taken.

Regarding the power of the supervisory authority in case of an unlicensed mode of operation, see Article 7 (2) (ii).

In case of non-fulfilment of the licensing provisions or the supervisory orders, the supervisory authority of the respective *Land* is authorised to enforce their fulfilment by coercive administrative measures in accordance with the general provisions applicable to the police authorities of the *Land*.

Enforcement by modification or revocation of the licence

Under certain conditions, stipulated in Section 17 of the Atomic Energy Act, obligations for ensuring safety may be decreed by the nuclear licensing authority even after a licence has been granted. In case a considerable hazard is suspected from the nuclear installation endangering the persons engaged at the plant or the general public, and cannot be removed within a reasonable time by appropriate measures, then the licensing authority has to revoke the issued licence.

A revocation is also possible if prerequisites for the licence permit cease to be met at a later time or if the licensee violates legal regulations or decisions by the authorities.

Prosecution of violations of nuclear law provisions

In addition, the Penal Code (StGB) [1B-11], the Atomic Energy Act [1A-3] and the nuclear regulatory ordinances provide sanctions to prosecute violations.

Criminal offences

Any violation that must be considered as a criminal offence is dealt with in the Penal Code. Imprisonment or a fine are imposed on anyone who, for example,

- operates, otherwise holds, changes or decommissions a nuclear installation without the required licence (Section 327 StGB),
- knowingly constructs a defective nuclear installation (Section 312 StGB),
- handles nuclear fuel without the required licence (Section 328 StGB),
- releases ionising radiation or causes nuclear fission processes that can damage life and limb of other persons (Section 311 StGB), or
- procures or manufactures nuclear fuel, radioactive material or other equipment for himself with the intent of performing a criminal offence (Section 310 StGB).

Administrative offences

Sections 46, 49 of the Atomic Energy Act and the related ordinances deal with administrative offences and provide for the imposition of fines on the acting persons.

An administrative offence is committed by anyone who, for example,

- constructs a nuclear installation without a licence permit,
- acts in violation of a regulatory order or provision,
- handles radioactive material without a valid licence permit, or
- as the ultimately responsible person fails to see to it that the protective and surveillance regulations of the Radiation Protection Ordinance are fulfilled.

The Atomic Energy Act and the related ordinances require that the persons are named who are ultimately responsible for the handling of radioactive material, for the operation of nuclear installations or for their surveillance. A person committing an administrative offence is personally liable for a fine up to 50,000 Euros. A legally effective fine against a person may put in question the personal trustworthiness that was a prerequisite for the licence and may, therefore, require the replacement of this person in his/her position of responsibility.

Experience

As a result of the intense regulatory supervision (→ Article 7 (2iii)) carried out in Germany in the course of design, construction, commissioning, operation and decommissioning of nuclear installations, any inadmissible condition is usually detected at an early stage before the possible legal actions, such as imposed obligations, orders, administrative offence procedures and criminal proceedings, have to be taken.

The instruments presented have proven their effectiveness since, in the normal case, they ensure that the authorities have appropriate sanction possibilities and authorisations for the enforcement of regulations and provisions, if required.

Article 7: Progress and changes since 2007

In April 2009, the draft of the new “Safety Criteria for Nuclear Power Plants” was presented. The Federation and the *Länder* agreed on a procedure providing application on a trial basis in parallel to the existing rules and regulations.

Within the reporting period, the draft Action Plan for transposition of the WENRA reference levels into the national nuclear rules and regulations has been updated. The progress of work is reported to the WENRA RHWG.

In recent yeas, the reporting criteria have been revised along with the amendment of the Nuclear Safety Officer and Reporting Ordinance [1A-17]. For practical considerations, the reporting criteria will, in future, be subdivided into separate technical parts for nuclear power plants, for research reactors, for facilities of the nuclear fuel cycle, for all decommissioned nuclear installations as well as for the storage of spent fuel elements. The amended Nuclear Safety Officer and Reporting Ordinance entered into force in summer 2010.

Within the reporting period, the BMU intensively participated in the further development of the IAEA safety standards. For increased involvement of also the nuclear authorities of the *Länder*, a report on the further development of the IAEA standards is submitted to the General Committee on an annual basis. During the reporting period, experts of authorities, authorised experts and operators actively participated in the development of the IAEA safety standards.

From 2007 to 2009, 13 KTA safety standards were revised, one new KTA safety standard developed and 4 new KTA safety standards have been initiated.

Important focal points of supervision activities, with which the German supervisory authorities took into account the principles established in Articles 9 to 19 of the Convention on Nuclear Safety and general safety considerations also with regard to operating experience and other new findings, are presented in the following under the respective articles.

Article 7: Future activities

The contents of Council Directive 2009/71/EURATOM of the European Union of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations [1F-1.25] to be implemented will be transposed into the German nuclear law in a legally binding form by 22 July 2011.

A comprehensive consultation procedure, involving the *Länder*, power utilities and science, aims to gain practical experience with the draft of the new Safety Criteria on the basis of which the draft is to be revised. The Federation and the *Länder* are striving for a unanimous adoption.

There is a regular review of KTA safety standards. If necessary, KTA safety standards are revised or newly developed.

For implementation of the WENRA reference levels in German plants, concertation of the Action Plan with the *Länder* will take place.

Germany continues to participate actively in the development of the IAEA safety standards. In this respect, Germany uses the international findings for further development of its own nuclear rules and regulations and makes its experience from the development of German rules and regulations available internationally.

Germany will invite to conduct an IRRS follow-up mission and present the measures taken.

8 Regulatory body

ARTICLE 8 REGULATORY BODY

1. Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.
2. Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organization concerned with the promotion or utilization of nuclear energy.

The content of Article 5 of Council Directive 2009/71/EURATOM establishing a Community framework for the nuclear safety of nuclear installations [1F-1.25] (Competent regulatory authority) follows Article 8 of the Convention on Nuclear Safety.

According to Article 5 para 1 of the Directive, Member States shall establish and maintain a “competent regulatory authority” in the field of nuclear safety of nuclear installations (definition in Article 3 number 3 of the Directive).

Article 5 para 2 of the Directive regulates that the regulatory authority functions of licensing and supervision of nuclear installations are separate from tasks concerned with the promotion and utilisation of nuclear energy.

Article 5 para 3 of the Directive concerns the powers and obligations of the regulatory authority, in particular with regard to the operation of nuclear installations. There, it is also stipulated that the authorities shall be provided with the human and financial resources necessary to fulfil their obligations.

8 (1) Authorities, committees and organisations

Composition of the regulatory body

Germany is a federal republic. Unless otherwise specified, the execution of federal laws lies in principle within the responsibility of the *Länder*.

The "Regulatory body" is therefore composed of federal government and *Länder* government authorities (→ Figure 8-1).

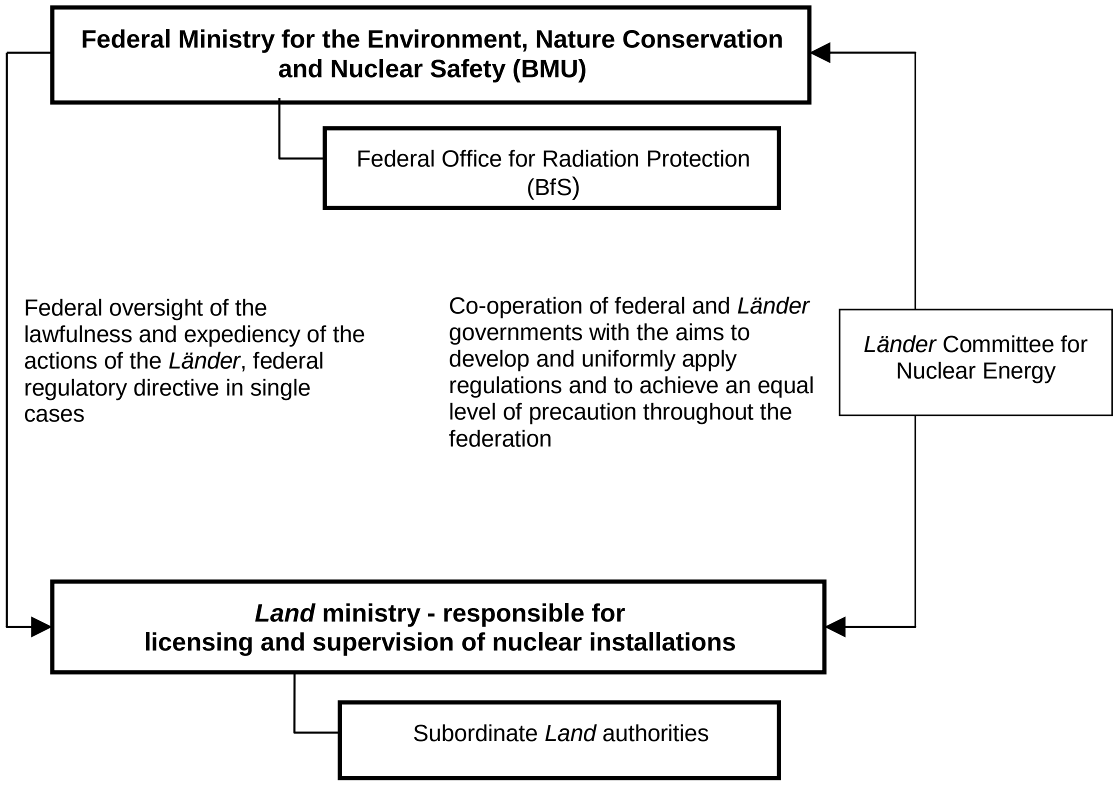


Figure 8-1 Organisation of the regulatory body

By organisational decree, the Federal Government specifies the Federal Ministry competent for nuclear safety and radiation protection. In 1986, this competence was assigned to the then newly founded Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) [1A-23]. Previously, the Federal Ministry of the Interior had been competent for environmental protection as well as for atomic law. The responsibility for the organisation, staffing and financing of the Federal Government's nuclear regulatory authority thus lies with the BMU. The BMU has the organisational powers and applies for the requisite human and financial resources from the annual federal budget.

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

The fundamental regulations for the further official competences are contained in the Atomic Energy Act (AtG) [1A-3] in Sections 22 - 24. According to Section 24, the respective *Länder* governments determine the supreme *Länder* authorities in charge of the licensing and supervision of nuclear power plants. Hence the responsibility for the organisation, staffing and financing of these executive authorities lies solely with the respective *Länder* governments. In individual cases, subordinate authorities may also be tasked with supervisory functions.

Table 8-1 The *Länder* licensing and supervisory authorities for nuclear installations according to the Convention

<table>
<tr><th>Land</th><th>Nuclear installations</th><th>Licensing authority</th><th>Supervisory authority</th></tr>
<tr><td>Baden-Württemberg</td><td>Obrigheim
Neckarwestheim 1
Neckarwestheim 2
Philippsburg 1
Philippsburg 2</td><td>Ministry of the Environment, Nature Conservation and Transport
in agreement with
Economics Ministry and Interior Ministry</td><td>Ministry of the Environment, Nature Conservation and Transport</td></tr>
<tr><td>Bayern</td><td>Isar 1
Isar 2
Grafenrheinfeld
Gundremmingen B
Gundremmingen C</td><td>State Ministry of the Environment and Public Health
In agreement with
State Ministry of the Economy, Infrastructure, Transport and Technology</td><td>State Ministry of the Environment and Public Health</td></tr>
<tr><td>Hessen</td><td>Biblis A
Biblis B</td><td colspan="2">Ministry of the Environment, Energy, Agriculture and Consumer Protection</td></tr>
<tr><td>Niedersachsen</td><td>Unterweser
Grohnde
Emsland</td><td colspan="2">Ministry for the Environment and Climate Protection</td></tr>
<tr><td>Schleswig-Holstein</td><td>Brunsbüttel
Krümmel
Brokdorf</td><td colspan="2">Ministry of Justice, Equality and Integration</td></tr>
</table>

Assignment of functions and competencies of the regulatory body to the federal and *Länder* government authorities

The regulatory body tasked with the implementation of the framework for legislation and execution defined in Article 7 (1) thus consists essentially of the BMU and the competent supreme *Länder* authorities. According to Article 7 (2), this "regulatory body" has to fulfil four basic functions:

- the development of safety procedures and regulations,
- licensing procedures,
- regulatory examination and assessment, and
- execution and inspection.

From the Articles of the Convention listed below ensue the following further functions to be fulfilled by the "regulatory body":

- regulatory safety research (Art. 14, 18, 19),
- system for the application of operating experience (Art. 19),
- radiation protection (Art. 15),
- emergency preparedness (Art. 16) and
- international co-operation (Preamble vii and viii, Art. 1).

In Germany, these functions are distributed among federal and *Länder* government authorities. Nuclear regulatory authorities exist in all of the *Länder*.

Table 8-1 lists the licensing and supervisory authorities of those *Länder* in which nuclear installations in terms of the Convention are located.

In principle, federal as well as *Länder* government authorities are involved in all functions, albeit with different competencies, responsibilities and duties to co-operate. This distribution is shown in Table 8-2. Further details are provided in the respective relevant chapters of this report.

The current Federal Government has no plans to change the existing basic structure of nuclear administration - i.e. the distribution of functions among federal and *Länder* governments - in Germany. The effectiveness of the regulatory body in Germany, however, is to be developed further and optimised. The IRRS mission conducted in 2008 is to contribute to such optimisation.

<u>Subordinate federal government authority - Federal Office for Radiation Protection</u>

The subordinate authority to the BMU in the area of radiation protection and nuclear safety is the Federal Office for Radiation Protection (BfS), which was established by the corresponding Act of Parliament of 9 October 1989 [1A-22]. The four technical departments of the Federal Office for Radiation Protection deal with the tasks provided by the Act in the areas of environmental and industrial radiation protection, radiation biology, radiation medicine, nuclear fuel supply and waste management, and nuclear safety. The issues concerning the Convention on Nuclear Safety are mainly dealt with by the "Nuclear Safety" directorate. It supports the BMU technically and scientifically, especially in the execution of oversight with regard to legality and expediency, the preparation of legal and administrative procedures, and in intergovernmental co-operation.

Table 8-2 Assignment of the regulatory functions to the nuclear authorities of the Federation and the *Länder*

Regulatory function	Functions and responsibilities of the regulatory body Federal Government authorities	*Länder* government authorities
Main functions		
Establishment of national safety requirements and regulations [Art. 7 (2) (i)]	Further development of the legal requirements (decision by Parliament in the case of formal Acts, by Federal Government with approval of the Bundesrat in the case of ordinances) and the regulatory guidance instruments	Participation on the basis of consolidated findings and needs in connection with execution; supplementary administrative procedures of the respective *Länder*
Licensing system with regard to nuclear installations [Art. 7 (2) (ii)]	Oversight with regard to legality and expediency* Checking of consolidated findings with regard to their relevance to standard national requirements	Checking of applications and notifications according to Section 7 AtG, granting of licences and approvals
System of regulatory inspection and assessment of nuclear installations [Art. 7 (2) (iii)]	Oversight with regard to legality and expediency* Checking of consolidated findings with regard to their relevance to standard national requirements	Controls and inspections in the nuclear facilities, checking and assessment with regard to the relevance to the safety of the installation as well as to protection and prevention measures
Enforcement of applicable regulations and of the terms of licences [Art. 7 (2) (iv)]	Oversight with regard to legality and expediency* Checking of consolidated findings with regard to their relevance to standard national requirements	Implementation of necessary measures to avert hazards and concerning necessary safety improvements and improvements of protection and prevention measures
Secondary functions		
Regulatory safety research	Investigation of safety issues for standard requirements	Plant-specific studies
Monitoring of events, operating experience and implementation	Examination and assessment of events in Germany and abroad with regard to generic relevance to the safety of the installations as well as to protection and prevention measures, national organisation of experience feedback	Examination and assessment of events with regard to relevance to the safety of the installations as well as to protection and prevention measures
Radiation protection, environmental monitoring	Monitoring of the radiation exposure of the population and the federal territory	Plant-specific monitoring of emissions and immissions (radiation exposure of workers and in the environment)
Emergency preparedness	Preparation and planning of general requirements; cross-national emergency preparedness, international reporting systems	Participation in the preparation and planning of general requirements, plant-specific emergency protection
International co-operation	Participation in international activities to determine the state of the art in science and technology and regarding the nuclear regulations, and provision for national purposes; Fulfilment of international obligations; assertion of German safety interests	Consideration of the internationally documented state of the art in science and technology Participation in the co-operation with neighbouring countries in the case of installations close to the border, especially on the basis of bilateral agreements

Grey	Leading function, execution within area of competence
Light grey	Function with separate competences but common objectives
White	"Federalism function" oversight with regard to legality and expediency or participation (e.g. in the *Länder* Committee for Nuclear Energy (LAA), by provision of information)

* This also means that the Federal Government may execute its power to decide the respective matter in hand itself and initiate on its own authority the corresponding detailed examinations.

<u>Subordinate authorities in the *Länder*</u>

As nuclear licensing and supervision is a function assigned to the supreme *Länder* authorities (ministries), only a few tasks are fulfilled by subordinate *Länder* authorities. In Baden-Württemberg, for example, measurements for the environmental monitoring of the nuclear power plants are performed by the State Institute for Environment, Measurements and Nature Conservation (LUBW), which is subordinate to the Ministry of the Environment, Nature Conservation and Transport. This Institute also operates the computer and monitoring networks of the NPP remote monitoring (KFÜ) system.

Co-operation between the authorities of the regulatory body - *Länder* Committee for Nuclear Energy

The *Länder* Committee for Nuclear Energy (LAA) is a permanent Federation-*Länder* Committee composed of representatives from the *Länder* nuclear licensing and supervisory authorities and the BMU. It serves for the preparatory co-ordination of Federal and *Länder* authorities in connection with the execution of the Atomic Energy Act as well as for the preparation of amendments and the further development of legal and administrative provisions as well as of the regulatory guidance instruments. In the interest of an execution of nuclear law that is as uniform throughout Germany as possible, the competent nuclear licensing and supervisory authorities of the *Länder* and the BMU draft any regulations on the uniform handling of nuclear law in consensus. These regulations are then promulgated by the BMU. The BMU chairs the LAA and also manages its affairs. The Committee's decisions are usually by mutual consent.

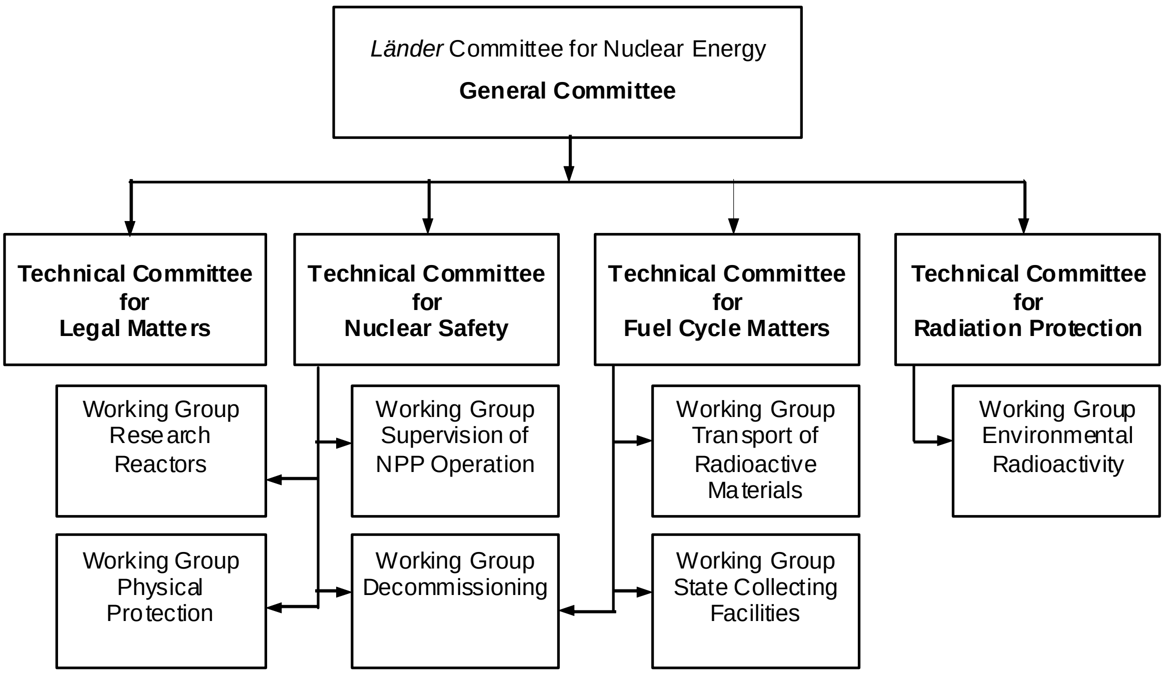


Figure 8-2 *Länder* Committee for Nuclear Energy

For preparing decisions to be taken by the General Committee, the *Länder* Committee for Nuclear Energy (→ Figure 8-2) avails itself of several Technical Committees on the issues of "Legal Matters", "Nuclear Safety", "Radiation Protection" and "Fuel Cycle Matters" as well as of the Working Groups assigned to these Technical Committees for special permanent tasks. If need be, the Technical Committees may set up ad hoc Working Groups for special and above all urgent individual issues. The Technical Committees and the permanent

Working Groups convene at least twice a year and more frequently if necessary. The General Committee convenes at least once a year.

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

Organisation and staffing of the nuclear authorities of Federation and *Länder*

Nuclear authority of the Federation

The nuclear authority of the Federation is a technical department (Directorate-General) of the BMU. It comprises three directorates. The entities of Directorate-General RS dealing with the fulfilment of the obligations under the Convention on Nuclear Safety are Directorate RS I and some divisions of Directorate RS II.

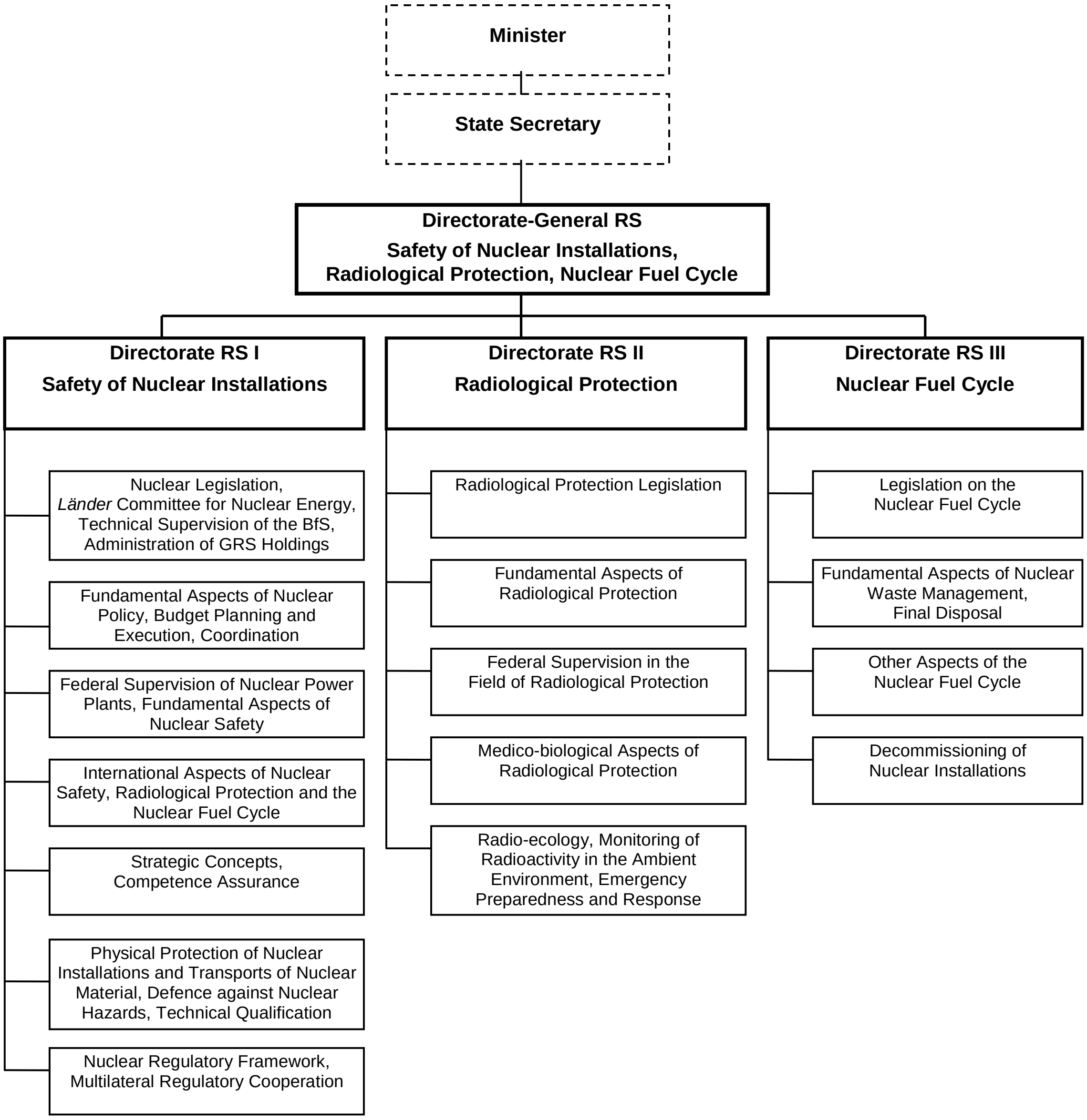


Figure 8-3 Organisation of the Directorate-General Nuclear Safety and Radiation Protection

The staff of the Ministry usually consists of civil servants appointed for life or public sector workers.

The legal civil servants or public sector workers are required to have qualified at university and to have passed the corresponding examinations. The scientific-technical civil servants of the Directorate-General RS are required to have completed a corresponding course at a university (senior service) or a university of applied sciences (higher service). Other than that, there are no relevant regulations concerning training and qualification.

Directorate RS I is the one mainly responsible for the fulfilment of the BMU's obligations under the Convention. As at mid-2010, staffing of Directorate RS I with *legal experts* under permanent contract (including staff of other non-technical disciplines such as business administration or economics) and with scientific and technical civil servants or public-sector employees of the higher or senior service - i.e. *technical staff* - was as follows (→ Figure 8-4):

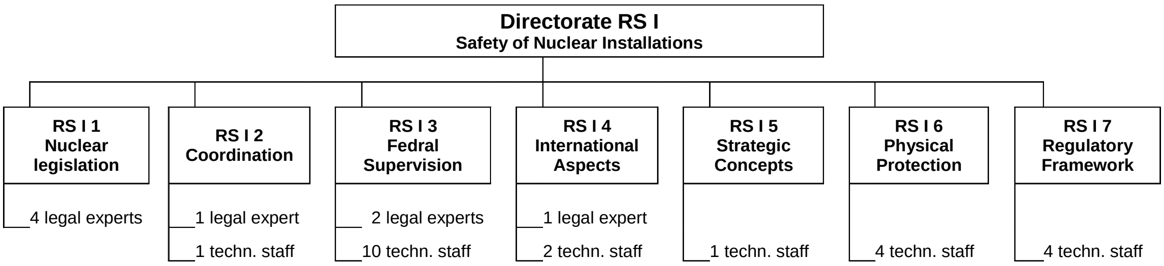


Figure 8-4 Organisation and staffing of Directorate RS I

In Directorate RS II, there are a total of 10 scientific-technical staff concerned with topics of radiation protection/emergency preparedness and response as affecting the scope of this Convention.

Taking into account staff entering or leaving, the staffing situation has remained unchanged. Given the current tight budget situation, additional posts are not to be expected. Regarding the staffing of the federal nuclear authority it has to be taken into account that the latter avails itself of the scientific and technical support of BfS, of GRS in its function as authorised expert organisation of the Federal Government as well as of other authorised experts. Budget resources to the amount of about 22 million Euros are provided each year for such contract placing (see section on financial resources of the "regulatory body").

Nuclear authorities of the *Länder*

The nuclear authorities of the *Länder* for the supervision of nuclear energy are the supreme *Länder* authorities (ministries) determined by the *Länder* governments. The assignment of the competence to the ministries is by ordinance or by other organisational decree of the *Länder* governments. Table 8-1 shows the ministries competent for nuclear installations according to the Convention. Within these ministries, the functions of the nuclear authority are usually fulfilled by ministerial directorates. The structure of such directorates depends on the kind and scope of the nuclear activities and installations in the *Land* concerned. The directorates are in turn subdivided into divisions for the execution of the licensing and supervisory procedures for the nuclear installations and are supported by additional divisions dealing with radiation protection and environmental radioactivity, waste management, fundamental issues, and legal affaires. In some *Länder*, nuclear fuel cycle facilities not pertaining to the scope of the Convention have to be supervised in addition to nuclear power plants.

The directorate for the supervision of nuclear energy is usually supported by a further organisational unit of the ministry; often this is a directorate for central tasks (e.g. human resources and budget-related affairs, infrastructure tasks and general services).

The illustration in Figure 8-5 shows a basic organisation chart of a directorate for the supervision of nuclear power at the *Länder* level.

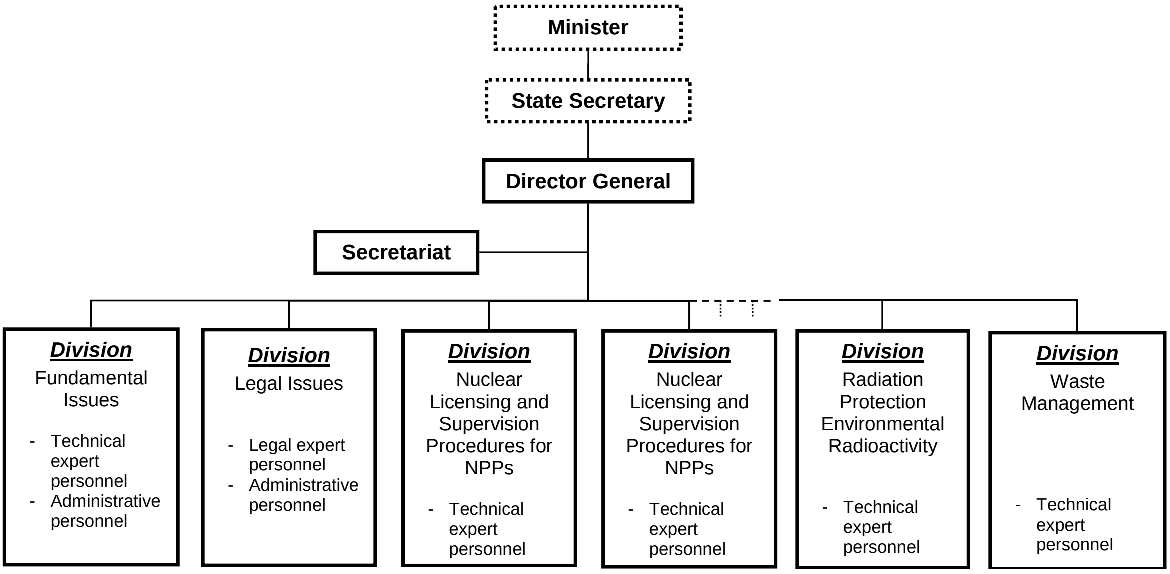


Figure 8-5 Basic organisation of a *Länder* Ministry directorate for the supervision of nuclear facilities

The directorates for the supervision of nuclear energy mainly employ technical specialist staff, especially engineers and scientists. They also have legal experts and administrative staff. All these directorates mainly carry out reviews and assessments as well as tasks related to the execution of the nuclear licensing and supervisory procedure as described in more detail in the following chapters. There is no strict allocation of staff to the tasks "Review and Assessment" and "Licensing" or to "Inspection". The staff is furthermore tasked with the management and deployment of the authorised experts consulted as well as with the review and assessment of expert opinions.

The majority of the work has to do with the work on licences and the execution of concrete nuclear power plant supervision. The collaboration in the co-ordination of a uniform framework for licensing and supervision in the Federal/*Länder* committees as well as in the drafting of the safety requirements and regulations mentioned in Article 7 (2) (i) require a working effort that is not to be ignored. Its share depends on the extent of the nuclear energy programme of the *Land* and of the size of the respective organisation. Usually, it takes up between 10 – 15 % of the total effort.

Regarding the staffing of the nuclear authorities of Federation and *Länder* it has to be taken into account that according to Section 20 of the Atomic Energy Act authorised experts may be consulted in the nuclear administration procedure. The *Länder* nuclear licensing and supervisory authorities make regular and extensive use of this option due to the large extent of the inspections and the associated wide scope of different scientific and technical disciplines required as well as the special technical equipment and computer systems needed. To carry out the nuclear licensing and supervisory procedures, about 30 - 40 man-years are required for one single nuclear power plant each year. This includes the work of the authority staff and of the authorised experts consulted. The scientific-technical competence needed is also contributed by authorised experts.

Competence of the "regulatory body" staff

In its former reports under the Convention on Nuclear Safety, the Federal Government has affirmed that efficient and competent regulatory supervision is necessary during operation of the nuclear power plants and during their decommissioning: "To ensure this, the government agencies responsible in Germany will guarantee the necessary financial resources, the technical competence of their personnel, the required number of personnel as well as an expedient and effective organisation."

A large number of experienced personnel of the nuclear licensing and supervisory authorities has already reached retirement age and left in the last few years or will do so in the years to come. This generation change represents a great challenge for the nuclear authorities, which have to compensate the loss of informed and experienced personnel by suitable measures in order to maintain the competence of the regulatory body in the field of nuclear safety and radiation protection. The situation is further aggravated by the fact that government saving measures often mean that positions that become vacant in particular at the federal nuclear authorities (BMU, BfS) are either not re-filled at all or only partly, usually with university graduates without any special nuclear knowledge.

A first step was to be a systematic "competence loss analysis" of the nuclear authorities and the subordinate authorities. The aim of the study was to find out which expert personnel were going to retire and what technical competences needed for the authorities' work would thereby be lost. However, this competence loss analysis could not be brought to an end for reasons, for example, of data protection. Apart from that, some countries perform systematic measures for maintaining competence of the nuclear supervisory authorities.

Competence and personnel development at the federal nuclear authority

A personnel development concept to ensure personnel levels could not be established due to the budgetary boundary conditions. In the area of Directorate RS I, however, competence could be strengthened in particular by the recruitment of junior personnel. The loss of experience was largely compensated by the documentation of knowledge and by interviewing those who were about to retire, and the commitment of the junior personnel was successfully steered towards the acquisition of the knowledge thus preserved.

An employment condition for technical personnel is a university degree in the relevant discipline. The knowledge needed for the special tasks (expert nuclear knowledge, administrational knowledge, etc.) is imparted in special courses during an introductory phase as well as by on-the-job training. The technical qualification and further education of newly employed personnel is mainly realised by participation in the one-year trainee programme carried out by the expert organisation GRS (GRS Academy) as well as by participation in external events, such as specialist seminars and simulator training.

Further qualification as well as advanced training and professional development are addressed in the regular appraisal interviews held with all members of the personnel.

Competence and personnel development at the *Länder* nuclear authority

The *Länder* nuclear authorities, too, are faced with special challenges regarding competence maintenance due to general budget saving measures. However, the situation compared with the Federation is a different one since according to the Nuclear Costs Ordinance (AtKostV) [1A-21], the cost of the work of the authority has to be born by the plant operators. Nevertheless, special efforts are required to maintain the necessary staff levels and ensure the timely introduction of succeeding personnel to their particular fields of work. Reviews have led to a strengthening of personnel organisation and an improvement in the ratio of filled positions at some authorities.

New employees are to take part in the process of knowledge transfer of the authorities on the basis of a policy of overlapping re-occupation of positions. Their introduction to their respective fields of work is based on individual on-the-job training plans. Each individual on-the-job training plan comprises different training and further qualification measures, the introduction to special fields of work, and guidance for independent acting. Depending on the intended area of work and already available knowledge, the junior personnel is trained in all relevant technical and legal areas.

In addition, the personnel of the *Land* authority who already look back on many years in employment there and who have gained a large amount of experience are officially obliged to keep their technical qualification constantly up to date and to take part in the corresponding measures for their further qualification.

An employment condition for technical personnel is a university degree in the relevant discipline. In the past, university graduates have employed as well as persons who have gained professional experience at commercial inspectorates, authorised experts, in industry and in science. The knowledge needed for the special tasks of regulatory supervision (expert nuclear knowledge, administrational knowledge, etc.) is imparted in special courses during an introductory phase as well as by on-the-job training with guidance by a mentor. Continuous checks of the working performance and results are made by the superior. Further qualification is addressed in the regular appraisal interviews.

The fact that authorised experts are consulted for various different licensing and supervisory procedure demands that the regulatory officials have a broad, generalist knowledge. For example, they have to verify whether the authorised experts' comments cover all relevant areas and have to come to a decision of the basis of different comments. Some *Land* authorities have appointed so-called technical co-ordinators for individual technical fields in which these excel by having special knowledge.

<u>Information and knowledge management system</u>

To preserve part of the knowledge gained from past experience and to make it accessible to future personnel, an information management system is set up at the BMU in close collaboration with GRS. For this purpose, compilations of documents and technical information relevant to nuclear authorities and expert organisations are classified, structured and provided electronically. The personnel are to be given direct access to the information relevant to their work on their desktop computers, doing away with traditional files and time-consuming searches.

As the international exchange of information and knowledge is becoming increasingly important for the execution of the Atomic Energy Act and for regulatory co-operation, there is close networking with international information services and databases.

Financial resources of the "regulatory body"

The financial means available to the authorities for their own personnel and for the consultation of experts are fixed by the Federal Parliament (*Bundestag*) and the *Länder* parliaments in their respective budgets. The applicants and licensees are invoiced by the *Länder* for the project-specific costs of licensing and supervision. There is no refinancing of the activities of the federal nuclear authority since, according to the principles of the German law on fees, no fees can be charged to the operators of nuclear installations for this oversight of the federal nuclear authority towards the *Länder* authorities.

In principle, the granting of licences for nuclear power plants and the supervision activities of the *Länder* are with costs. The costs are paid by the licensee to the treasury of the respective *Land*. For a construction and operating licence of a nuclear power plant, altogether 2 tenths of a percent of the construction costs have to be paid. A modification subject to licensing costs between 500 Euros and 100,000,000 Euros. The costs of supervision are invoiced by the actual effort involved in the individual activities and lie between 25 Euros and 500,000 Euros. The remuneration for the authorised experts consulted is also refunded by the applicant or licensee as expenses.

The BMU can dispose of an approximate annual 22 million Euros from the federal budget for studies related to nuclear safety. These funds are used for the financing of the work of the advisory commissions, for the direct support of the federal nuclear authority, for scientific and technical studies as well as for the participation of external experts in international co-operation. Corresponding programmes are perpetuated by the BMU every year and concern particularly the evaluation and assessment of operating experience, studies into special safety-related issues, the further development of technical requirements for nuclear installations as well as work on technical and other individual questions in connection with the licensing and supervision of nuclear installations. These programmes are administered by the BfS and in part also technically controlled.

In addition, an approximate annual total of 9 million Euros is spent on studies related to radiation protection.

Management systems of the "regulatory body"

The management system of the Directorate-General RS is based on organisational decrees, responsibility schedules, rules of internal procedure, and procedural instructions as they generally apply to supreme federal authorities.

In addition, a special process-based quality management system has been introduced for the BMU Directorate-General RS.

Over a period of about two years, all relevant processes were initially identified by means of an as-is analysis, and the processes sequences were described. In a next step, the processes were summarised in process groups and optimised in collaboration with all those involved in the individual processes.

Since August 2005, the descriptions of the process sequences have been available to all personnel of Directorate-General RS in the form of an electronic manual (overview of the process model → Figure 8-6) and are continuously revised.

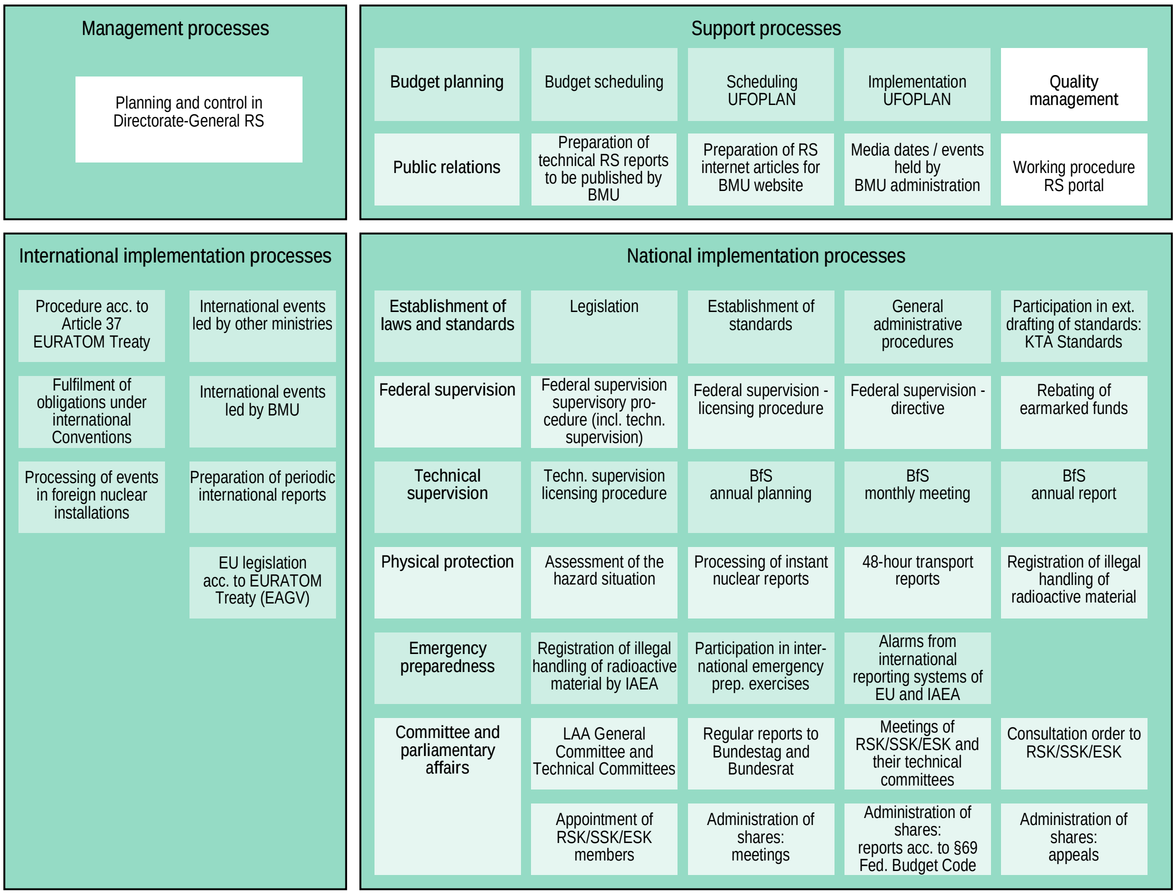


Figure 8-6 Process model of the Directorate-General RS (Nuclear Safety)

The quality management system in the chosen form is both working principle and instrument of effective administrational control, supporting the senior personnel in carrying out their managerial functions. It should contribute to raising the quality and efficiency of the work and offers the individual help in better coping with the increasing workload. In addition, it is ensured by documentation of the processes and work instructions that experience is passed on specifically and is not lost as a result of the retirement of personnel.

The central process of the management system is the management process "Planning and Control in Directorate-General RS". The aim of this process description is to lay down how the planning and steering within the Directorate-General RS is to take place. With this process description it is to be ensured, in particular, that

- by elaborating the strategic aims of the Directorate-General RS, the definition of the key political strategies of the BMU is prepared,
- the measures to reach the strategic aims of the Directorate-General RS are implemented systematically and consistently with participation of the personnel,
- the responsibilities within the Directorate-General RS as well as the target values of each individual strategic target are defined,
- the strategic plan of the Directorate-General RS is defined and continuously checked for the degree of its fulfilment, its topicality, content and time frame and that it is revised and supplemented if necessary, and
- the control of the fulfilment of the strategic aims the Directorate-General RS and the control of the status of the individual measures takes place on a continuous basis.

Development of management systems at *Länder* authorities

Irrespective of the fact that work sequences and processes of nuclear regulatory authorities are already largely regulated by the established organisational procedures for *Land* ministries, further developed approaches to these management systems that are specific to nuclear regulation are employed where applicable.

The authorised expert organisations consulted by the *Länder* licensing and supervisory authorities are certified according to the international quality assurance standards ISO 9001/2000. Some of the *Länder* authorities have their own quality management systems; others are in the process of building up such systems. Here, the activities are focused on the description and analysis of process sequences in connection with the nuclear licensing and supervisory procedure.

Support by the Federal Office for Radiation Protection, advisory commissions and authorised experts

Federal Office for Radiation Protection (BfS)

The support of the BMU by the BFS is provided by several of its departments, but mainly by the department "Nuclear Safety" (SK). At present, there are 22 scientific and technical personnel employed in this department working in five sections.

Main topics dealt with concerning the Convention on Nuclear Safety are as follows:

- Documentation of the licensing status and the residual electricity production rights of nuclear power plants,
- documentation and initial assessment of reportable events,
- methods and status of the safety reviews,
- selected safety issues,
- international co-operation,
- national and international regulations,
- keeping of a register of occupational radiation exposure,
- control programme for emission monitoring of nuclear installations,
- large-scale monitoring of environmental radioactivity, and
- support and administration of regulatory study projects.

The kind and extent of the support is co-ordinated on an annual basis between the BMU and BfS as part of their annual planning.

Within the reporting period, the entire BfS as well as its Department SK Nuclear Safety has not been able, in sum, to acquire additional personnel and thus no additional technical competence due to the restrictive requirements of the federal budget legislation. Several technical issues still cannot extensively be dealt with. As part of a step-by-step plan of the BMU for the years 2009 to 2011 it is intended to increase the number of new posts for the Department SK substantially. The extent to which this can be implemented is subject to the decisions of the budgetary legislator. New posts were approved for 2009 and 2010.

Reactor Safety Commission, Commission on Radiological Protection

The Federal Environment Ministry receives regular advisory support from the Reactor Safety Commission (RSK) and the Commission on Radiological Protection (SSK). The Reactor Safety Commission was founded in 1958, the Commission on Radiological Protection in 1974. It has to be ensured that the commissions are independent and well qualified and that their members reflect the whole spectrum of scientific and technical opinions. The statues commit the members to voicing their opinion in an objective and scientifically sound manner. The two commissions currently consist of 17 members (in 2010) each who are experts in different specialist fields. The members are appointed by the BMU. Their main activity lies in advising the BMU on issues of fundamental importance, but they also initiate developments directed at furthering safety technology. The results of the deliberations of the two commissions are formulated as general recommendations and as statements on individual cases, which are then published (www.rskonline.de, www.ssk.de).

Authorised experts

The profession of the authorised expert has a long-standing tradition in Germany. Its beginnings lie in the private steam boiler inspection agencies of the 19th century which helped improve the quality, safety and reliability of such facilities by introducing independent supervision.

Regarding the regulatory supervision of the peaceful use of nuclear energy, Germany - on the basis of the market-orientated structure of the Federal Republic - has like in other areas of technical supervision given preference to the co-operative relief of the state by private-sector forces of society over the build-up of large state authorities which would have to be staffed with sufficient personnel to deal with all the tasks involved exhaustively themselves. The special technical knowledge and independence are the decisive criteria for the involvement of authorised experts. Today, this is mainly ensured by the Technical Inspection Agencies (TÜV), which act on behalf of the authority as so-called "main consultants" of the *Länder* authorities.

Over the past decades, the Technical Inspection Agencies have built up large and powerful nuclear divisions or independent subsidiaries with considerable expert resources of about 1,000 specialists of the most varied disciplines. This is added by their experience from their work in the conventional, non-nuclear field. With only a few exceptions, they all dispose of the requisite knowledge in all relevant technical fields and ensure its sustained provision by taking suitable steps towards the acquisition and maintenance of competence as well as by a diversified exchange of experience in association with all other Technical Inspection Agencies.

In performing their licensing and supervisory activities, the *Länder* ministries may consult expert organisations or individual experts (Section 20 of the Atomic Energy Act).

Authorised experts are engaged with regard to almost all technical issues related to the assessment of the safety of the installations and their operation. They are particularly involved in all licensing procedures as well as in the supervisory procedures, like e.g. in the evaluation of operating experience, the assessment of reportable events, in in-service inspection, and in applications for smaller modifications.

The *Länder* authorities are not bound by the authorised experts' evaluation results in making their decisions. They have the necessary competences to fulfil their functions, which also involve the management of the authorised experts consulted.

The aspects to be considered when engaging authorised experts, e.g. regarding the aspects of

- vocational training,
- professional knowledge and skills,
- trustworthiness, and
- independence,

are specified in guidelines [3-8 and 3-34].

By involving authorised experts, an evaluation of the safety issues is performed that is independent of that of the licence applicant. The authorised experts perform their own tests and evaluations and their own calculations, preferably with methods and computer codes different from those used by the licence applicant. The persons involved in preparing the expert opinions are not bound by any technical directives and are reported to the respective authority by name.

The scope of expert services is always determined by the competent authority. The services of authorised experts are reimbursed by the plant operators.

For its federal oversight activities, the Federal Environment Ministry will equally consult national and international experts if necessary.

Gesellschaft für Anlagen- und Reaktorsicherheit

Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) is a central expert organisation. GRS performs scientific research in the field of nuclear safety technology, predominantly sponsored form federal funds, and is the main expert organisation advising the Federal Environment Ministry on technical issues. A limited amount of work is also performed by order of the licensing and supervisory authorities of the *Länder*. GRS employs more than 300 experts in the different fields related to nuclear safety.

IRRS self assessment and mission for the "regulatory body" in Germany

From 7 until 19 September 2008, an IRRS mission (IRRS = Integrated Regulatory Review Service) of the IAEA took place in Germany at the invitation of the BMU. It was the first IRRS mission of the nuclear authorities in Germany. On the part of the *Länder*, the nuclear authority of the *Land* of Baden-Württemberg (Ministry of the Environment, Nature Conservation and Transport Baden-Württemberg, UVM BW) participated in the IRRS mission.

In April 2006 and March 2007, the IAEA conducted two information workshops in Germany on the kind, procedure, contents and extent of an IRRS mission.

In two preparatory meetings (November 2007 and May 2008) between IAEA representatives, the head of the review team and the BMU and the UVM BW, the scope of the mission was defined, covering 8 issues (Module I - VIII according to the IRRS guidelines). The object of the review was the supervision of the safety of nuclear power plants by the regulatory bodies and individual aspects of radiation protection nuclear power plants.

Due to the division of tasks between the Federation and the *Länder*, one person primarily responsible (“liaison officer”) for the IRRS mission was appointed by the BMU and one by the UVM BW as well a counterpart each per module. The actual mission partly took place at the BMU in Bonn and partly at the UVM BW in Stuttgart.

The review team consisted of 12 international experts from 11 nations and three IAEA staff members. The expert team consisted of high-ranking representatives of the authorities from Great Britain, USA, Spain, Finland, Korea, the Czech Republic, Japan, the Netherlands, Switzerland, France and Canada.

In preparation for the mission, BMU and UVM BW conducted a self-assessment on the basis of the 248 questions of the IAEA guidance on how to conduct an IRRS mission, the "IRRS guidelines". On the basis of the improvement measures derived from it, both the BMU and the UVM BW developed action plans. The actions included, among others, the areas of personnel and knowledge management, public relations, further development of supervision, update of nuclear rules and regulations, national and international exchange of experience as well as further development of the regulatory management systems.

In accordance with the specifications of the IRRS guidelines, the required documents, the “advance reference material” was sent to the IAEA mid-June 2008. In addition to the basic information for the review team, these included a comprehensive report on the self-assessment of BMU and UVM BW, including answers to the IRRS questionnaire and the action plans. The “advance reference material” was submitted together with a number of supplementary documents, as e.g. a compilation of the relevant acts, rules, regulations and documents on the organisation and way of working of the authorities. With these documents, a comprehensive compendium on the German system of supervision was available to the international experts for preparation of the mission.

During the mission, the international reviewer had talks with the national counterparts and other authority staff. The different issues (modules) were dealt with by two review team experts each. The reviewers had discussions with the counterparts appointed by the BMU and the UVM BW for the topic in question as well as with other experts of the authority and representatives of the plant operator. As a result of the review, the review team made recommendations and suggestions with regard to improvements. Moreover, they identified items representing good practice at the international level.

The report of the review team was handed over to the BMU and the UVM BW by the IAEA on 28 November 2008. The complete report is published on the websites of the BMU (www.bmu.bund.de) and of the UVM BW (www.uvm.baden-wuerttemberg.de). As a result of the IRRS mission, the IAEA confirmed that the German nuclear supervision complies with high international standards. In its report, the review team made 13 recommendations and 34 suggestions for further improvement of the BMU and the UVM BW. Moreover, the team judged some approaches to be internationally outstanding and identified these practices as exemplary (4 good practices).

These include, among others, the KTA safety standards process and the UVM BW approach to systematically incorporate organisational and human factors in the oversight activities (MTO approach).

Based on the results of the IRRS mission, the BMU and the UVM BW revised their action plans and defined improvement measures for implementing the recommendations and suggestions. The follow-up mission, during which the BMU and the UVM BW will present to the reviewers what measures have been taken, is currently being prepared. The aim is to implement as many measures as possible until the follow-up mission.

From the German side, the instrument of IRRS missions is on the whole regarded as an instrument for mutual learning and for improving the performance of their tasks. Germany will continue to actively contribute to the application of this instrument and further development at the international level.

8 (2) Separation between the functions of the regulatory body and the utilisation of nuclear energy

Within the framework of the First Review Meeting under the Convention on Nuclear Safety, several contracting parties critically questioned the organisational separation of functions within German nuclear authorities as required by the Convention. In the centre was the question how far compliance with Article 8 (2) of the Convention is affected by the fact that the functions of nuclear regulatory supervision and energy industry promotion in parts rest within one single authority.

The Federal Government has therefore taken up this question and in the following, presents the results in detail. In summary, there is confirmation that in Germany the governmental institutions concerned with the utilisation or promotion of nuclear energy are sufficiently separated, both legally and administratively, from those institutions that are responsible for the licensing and supervision of nuclear installations.

Requirements of the Convention

Article 8 (2) of the Convention contains a protective provision which stipulates the organisational-structural separation of the licensing and supervisory functions of the state from its promotion function. The resulting consequences for the state concerning the organisation of the fulfilment of its functions can be determined from the purpose of the provision of Article 8 (2) as well as from the fact that the principle of separation has been formulated to be unspecific due to the sometimes very differently structured national legal systems in the states of the contracting parties. The principle of separation has also been enshrined in Article 5 para 2 of Council Directive 2009/71/EURATOM establishing a Community framework for the nuclear safety of nuclear installations [1F-1.25].

The Convention on Nuclear Safety serves for the preservation and further development of the safety level of nuclear installations.

In this connection, the effective separation stipulated in Article 8 (2) is to ensure that the supervision of nuclear installations remains uninfluenced by any promotion interests.

The above-mentioned fulfilment of the licensing and supervisory functions by state authorities necessarily entails the use of sovereign powers towards the plant operators. In a democratic state governed by the rule of the law, like the Federal Republic of Germany, the execution of state supremacy requires authorisation by the sovereign, i.e. the people. According to the constitutional provisions deriving from Article 20 para 2 of the Basic Law [1A-1], this authorisation is imparted by the ultimate responsibility of the respective political decision-makers.

Realisation in Germany

It has to be pointed out that legally, the licensing and supervisory authorities - both on federal and on *Länder* level - are administrative state authorities. Constitutional stipulations require them to act according to law and justice (Article 20 para 3 of the Basic Law [1A-1]). In this connection, emphasis is laid on the obligation pursuant to the Atomic Energy Act to take the necessary precautions against damage resulting from the erection and operation of the installation in accordance with the state of the art in science and technology.

Organisationally, a distinction has to be made between the activities of the competent licensing and supervisory authorities on *Länder* level and the powers of oversight and instruction held by the Federation.

On the level of the *Länder*, the principle of separation of Article 8 (2) of the Convention is adhered to on the basis of the organisational provisions realised in the *Länder*. The effective separation of the competent authorities for the area of nuclear licensing and supervision from other authorities which - as part of the overall energy policy or energy industry support - also deal with matters of nuclear energy is ensured by the fact that different ministries or different and independent organisational units within one and the same ministry are in charge of and responsible for the different functions.

To support the administrative state authorities in technical matters, these can consult experts - acting under civil law - who in turn are obliged to deliver impartial and qualified statements (→ Articles 7 (2) (ii) and (2) (iii) and Article 8 (1)).

The authority of the Federation to give directives concerning issues related to the licensing and supervision of nuclear installations - which is derived from Articles 85 para 3 and 87c of the Basic Law - lies with the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, which on its part does not fulfil any functions regarding the use and promotion of nuclear energy.

The BMU pursues developments of new reactor construction lines and new safety solutions to derive important knowledge concerning the safety of German nuclear power plants in operation.

In relation to the above-mentioned state agencies, the licensees of nuclear power plants - in their function as users and perhaps promoters of nuclear power - represent commercial enterprises under civil law. They are either power utilities themselves or are composed of shareholders from the ranks of the German power utilities.

These power utilities are also commercial enterprises under civil law, usually joint-stock companies (→ Article 11 (1)) and have no influence on the safety-directed actions of the licensing and supervisory authorities.

The governmental organisation in Germany fulfils the requirements of Article 8 (2) of the Convention.

Article 8: Progress and changes since 2007

The staffing situation at the regulatory body still needs to be improved.

Some nuclear authorities have managed to maintain the number of personnel and their competence or, in some cases, to increase it. However, the loss of competence of expert personnel with long-standing experience has progressed due to retirements. The federal authority in particular has not been able to compensate for this loss as job cuts have increased at the same time and it proved to be particularly difficult to recruit experienced staff.

The regulatory body continues to consult technical expert organisations such as GRS or the Technical Inspection Agencies. The expert organisations have established programmes that ensure the requisite numbers of personnel and their competence in the long run.

An IRRS mission was conducted in 2008. The self-assessment process carried out in preparation of the mission and the results of the mission itself were generally assessed positively. Improvement measures have been initiated. It is planned to conduct a follow-up mission.

Article 8: Future activities

The effectiveness of the regulatory body in Germany is to be further developed and optimised on the basis of the existing competences at the federal and *Länder* level under consideration of the recommendations and suggestions of the IRRS review team. The staffing situation is to be improved, as far as required. The competent federal and *Länder* authorities collaborate to this end.

The management system of the nuclear authorities will be developed further, taking relevant IAEA standards into account, and will be added by collaboration processes between the Federation and the *Länder*.

9 Responsibility of the licence holder

ARTICLE 9 RESPONSIBILITY OF THE LICENCE HOLDER

Each Contracting Party shall ensure that prime responsibility for the safety of a nuclear installation rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.

Legal and regulatory requirements

According to Article 6 para 1 of Council Directive 2009/71/EURATOM, Member States shall ensure that the prime responsibility for nuclear safety of a nuclear installation rests with the licence holder.

The regulations of the Atomic Energy Act [1A-3] on licensing and supervision are based on the principle of responsibility of the licensee. According to Section 7 of the Atomic Energy Act, the licence for construction and operation is only granted if the applicant proves that the necessary technical and organisational precautions for a safe operation have been taken. During operation, the plant operator has to fulfil his responsibility continuously. This is verified and ensured by the licensing and supervisory authority which has the means of Sections 17 and 19 of the Atomic Energy Act at its disposal (→ Articles 7 (2) (iv) and (2) (iii)).

Further, Section 7 of the Atomic Energy Act stipulates that the licence for construction and operation of a plant may only be granted if, among others, there are no doubts as to the trustworthiness of the applicant and the responsible persons and these persons have the necessary technical qualification.

In terms of the Radiation Protection Ordinance [1A-8], the holder of the licence is the “radiation protection supervisor” (Section 31 of the Radiation Protection Ordinance). In the case of corporate enterprises, the tasks of the radiation protection supervisor are fulfilled by a person authorised to represent the operating organisation. Status and duties of the radiation protection supervisor are specified in Sections 32 and 33. One of the duties of the radiation protection supervisor is to take protective measures to protect man and the environment from harmful effects of ionising radiation, taking due account of the state of the art in science and technology. The duties include, among other things, to provide appropriate installations and equipment as well as to ensure the adequate regulation of the operating procedures with sufficient and qualified personnel and protection against significant safety-related events.

An appropriate number of radiation protection commissioners for the control and surveillance of the above practice in question is appointed by the radiation protection supervisor to ensure radiation protection during operation of the nuclear facilities. The radiation protection supervisor shall also remain responsible if he has appointed radiation protection commissioners.

Furthermore, it is required according to the Nuclear Safety Commissioner and Reporting Ordinance [1A-17] to appoint a nuclear safety officer.

Rights and obligations of the nuclear safety officer are specified in Section 4 of the ordinance in a legally binding form. The tasks include, among others, the evaluation and implementation of operating experience as well as the report of reportable events (→ Article 19 (vi, vii)). Other responsibilities are specified in the regulatory guidelines on technical qualification [3-2] and [3-27].

According to regulatory guideline [3-2], the plant manager is ultimately responsible for the safe operation of the entire plant and, especially, for the fulfilment of the provisions and requirements under the Atomic Energy Act and licence permits. He is authorised to give orders to the heads of department or section.

The heads of department or section are responsible for their technical areas and are authorised to give orders to their subordinate personnel.

The responsible shift personnel - i.e. the shift supervisors and their deputies and the reactor operators - carry the responsibility that during operating conditions, the nuclear installation is operated in accordance with the written operating instructions, and with the prescribed operating schedule and that in case of accidents, appropriate actions are taken (direct operating process). This also includes the necessary measures in case of alarms and emergencies.

In addition to the above-mentioned persons, regulatory guideline [3-2] specifies the tasks of the training manager, the head of the quality assurance division and the physical protection officer.

When using external personnel, the applicant has to make sure that the necessary knowledge is ensured according to guideline [3-27] and, where required, by persons in support of them. This also applies to the case that knowledge is communicated by the contractor. This is to be demonstrated to the supervisory authority upon request.

Implementation and measures by the plant operators

All German companies operating nuclear power plants committed themselves in fundamental documents, such as management principles or corporate policies, to give priority to the safety of the nuclear power plants over all other business objectives. These documents include binding objectives for the entire company. Examples of such company-specific objectives are the following:

- The safety of the nuclear power plants has top priority. It is based on proven technology, adequate organisational specifications and qualified personnel.
- Safety-relevant processes are critically analysed, monitored and further developed.
- All actions/activities/measures are performed with the necessary safety awareness.
- The technical safety level reached and the condition of the plant in compliance with the requirements of the licence are maintained and further developed by means of adequate monitoring and maintenance concepts and by plant modifications.
- Electricity is produced in an environmentally friendly manner.
- Fast and comprehensive exchange of experiences on safety-relevant events or findings is of great importance for the German nuclear power plants.

The plant manager is responsible for the safe operation of a German nuclear power plant. In particular, he is responsible for the compliance with the provisions and requirements under the Atomic Energy Act and licence permits as well as for the co-operation of all divisions. The plant manager is authorised to give orders to the heads of department or section. In addition, different officials - required by law and independent of the hierarchy in the plant -

supervise safe operation within the plant.

The operators of the German nuclear power plants are members of the VGB PowerTech e. V. (VGB), a technical and standard-developing association of German and European power plant operators, under whose umbrella research and development work is jointly promoted in the field of “nuclear power plants”. The development of concepts, activities on updating the state of the art in science and technology and the exchange of experience among the plant operators are generally also organised via the VGB. Examples of the joint concept development are the following VGB documents: "Leitfaden zur Sicherheitskultur in deutschen Kernkraftwerken" (guideline on safety culture at German nuclear power plants), the framework paper "Sicherheitskultur in deutschen Kernkraftwerken - Konzept zur Bewertung und Trendverfolgung" (safety culture at German nuclear power plants - concept for assessment and trend analyses) and the "Konzept zur Optimierung des Sicherheits-managementsystems" (concept for the optimisation of the safety management system) as well as the jointly commissioned development of a system for integrated event analyses under consideration of human errors and possibilities for organisational optimisation.

International safety evaluations for German nuclear power plants are performed by the plant operators by WANO peer reviews.

The review team consists of highly qualified staff from other WANO members throughout the world. During the review, strengths are identified that may be useful to other plants, and deficiencies whose improvement can serve to enhance safety and reliability at the plant. A typical peer review examines the plant’s performance in the following areas:
- Organisation and administration
- Operations
- Maintenance
- Engineering support
- Radiation protection
- Operating experience

Cross-functional areas are, e.g.:
- Safety culture
- Human performance
- Self-valuation
- Industrial safety
- Plant status and configuration control
- Work management

An overview on the WANO peer reviews for the German nuclear power plants is given in Article 14 (ii).

The operators of the German nuclear power plants perform national peer reviews in the style of the WANO peer reviews. The aim of this initiative is to obtain representative information on the quality of the administrative/operative plant management, analogous to the WANO peer reviews, and to perform optimisations, if required. Thirteen representative processes (operation, maintenance, radiation protection/chemistry, evaluation of operating experience, technical qualification, engineering/contracting, FE handling, fire protection, quality assurance monitoring, accident management, modification procedures, procurement, safety management system) were selected for these reviews which are periodically performed by experts of other German plants for about three review days each. On average, a national peer review is performed at every German nuclear power plant once a year. An overview on the national peer reviews for the German nuclear power plants is given in 14 (ii).

Regulatory review

For the German nuclear power plants, the organisation charts, the responsible persons and their area of responsibility are documented in the plant personnel organisation. The plant personnel organisation is part of the safety specification (→ Article 19 (ii)) and a licensing document. During the licensing procedure, the licensing authority checks whether the responsibilities are specified in an appropriate manner. The plant operator informs the authority about changes in the organisation chart or of responsible persons. Changes in the plant personnel organisation are either subject to licensing by the licensing authority or to the approval of the supervisory authority.

In addition to the required technical qualification (→ Article 11 (2)), the supervisory and licensing authorities also evaluate the trustworthiness of the responsible persons of the plant operation and all persons working in safety-relevant areas. For assessment of the trustworthiness, an enquiry is made about findings of the police authorities. The persons may only start to work if the supervisory authority has no doubts as to their trustworthiness [1A-19].

Moreover, the nuclear authority also checks the trustworthiness of the applicant or licensee (of a corporation) or the persons representing him (e.g. the board members or directors).

The supervisory authority holds meetings with the board members or directors of the licensee to check how the persons responsible of the plant operators fulfil their responsibility for nuclear safety. Here, general questions relating to safety and the relationship between supervisory authority and plant operator can be brought up for discussion during which the supervisory authority ensures that the primary responsibility of the plant operator for safe operation is not impaired.

The supervisory authority regards all its activities performed within the framework of regulatory supervision as independent review to determine to which extent the license fulfils his responsibility for the nuclear safety of the plant.

Licensee for the construction of the plants

Within the framework of the fourth Review Conference, Germany was asked to describe in the report for the fifth Review Conference which regulations existed on the responsibility regarding the construction of the plants.

The construction process of the nuclear power plants took place on the basis of so-called partial construction licences.

With the 1st partial construction licence, e.g., licence was granted for the site, the safety concept and the construction of the main structures.

Other licensing steps included

- the installation of the safety-relevant mechanical and electrical systems and components,
- the handling and storage of fuel elements as well as loading of the reactor with fuel elements including the pre-operational tests,
- the final construction, the nuclear commissioning and the operation of the plant.

For the construction process, nuclear commissioning and operation, partial construction licences and construction licences were generally granted to the applicants. For construction and nuclear commissioning, these were in many cases the owner, the plant constructor and the future operator organisation.

Nuclear commissioning and trial operation were also performed under the responsibility of the plant constructor.

With acceptance of the plant by the operator, the responsibility was usually transferred to the operating organisation. In some plants, however, the plant constructor maintained responsibility for the operation until first refuelling.

After handing over of the responsibility for the operational management to the operating organisation, the licence for the plant constructor usually expired.

In some plants, other power utilities are also owner and holder of the operating licence in addition to the operating organisation.

In some plants, the power utilities involved founded own operating companies which then act as a licensee.

The nuclear responsibility for the operation of the plants is taken by the responsible personnel in the plants and a competent technical director.

Article 9: Progress and changes since 2007

The existing rules and procedures have proven to be effective so that, apart from the optimisation of details, no changes were required.

Article 9: Future activities

According to Article 6 para 1 of Council Directive 2009/71/EURATOM of 25 June 2009 [1F-1.25] establishing a Community framework for the nuclear safety of nuclear installations, "Member States shall ensure that the prime responsibility for nuclear safety of a nuclear installation rests with the licence holder. This responsibility cannot be delegated."

Council Directive 2009/71/EURATOM shall be implemented by the EU member states by 22 July 2011. The contents of the Directive have not yet been fully transposed into the relevant legal and administrative provisions of the Federation and the *Länder*. In co-operation with the licensing and supervisory authorities of the *Länder*, the Federal Government examines to what extent the legislative, regulatory and organisational framework is to be changed at the federal or *Länder* level.

10 Priority to safety

ARTICLE 10 PRIORITY TO SAFETY

Each Contracting Party shall take the appropriate steps to ensure that all organizations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety.

Legal and regulatory requirements

In Section 1 subpara 2, the Atomic Energy [1A-3] specifies as one of its purposes “to protect life, health and property against hazards of nuclear energy and the detrimental effects of ionising radiation and to provide compensation for damage and injuries caused by nuclear energy or ionising radiation“.

The principle of giving priority to safety is referred to in Article 5 para 3 sentence 1 (for authorities) and in Article 6 para 4 (for licence holders) of Council Directive 2009/71/EURATOM establishing a Community framework for the nuclear safety of nuclear installations [1F-1.25].

The assurance of nuclear safety is a central task of the Atomic Energy Act. The provisions of the Atomic Energy Act on licensing of nuclear power plants and supervision during operation serve the primary purpose (→ Article 7). In particular, Section 17 of the Atomic Energy Act stipulates that the authority may impose obligations subsequently if it is necessary to achieve this purpose of protection. Licences may also be revoked by the authority if necessary to avoid substantial hazards to the population.

According to Section 33 of the Radiation Protection Ordinance (StrlSchV) [1A-8], it is a primary duty of the radiation protection supervisor and the radiation protection commissioner to assure protection of man and the environment against detrimental effects of ionising radiation (→ Articles 7, 9, 15).

From this interrelation of the Atomic Energy Act and the Radiation Protection Ordinance it follows that the plant operator, who has the primary responsibility for the safety of the nuclear installation, can get a licence for construction and operation of a nuclear power plant and can maintain it on a sustained basis only if he gives the required priority to safety.

With the agreement between the Federal Government and the power utilities of 11 June 2001, these had declared that high safety level of the German nuclear plants, compared internationally, is also maintained during the remaining operating lives agreed upon.

In particular, it had been laid down that

- economic constraints must not lead to restrictions of safety precautions or to a renunciation of safety-related improvements, and
- safety-related competence has to be maintained as long as necessary for safe operation during the remaining operating lives.

The introduction of a safety management system and the related requirements are the subject of the principles paper [3-81] published by the Federal Environment Ministry in June 2004. The contents of this regulation largely cover the requirements of the IAEA Safety Standards GS-R-3.

The principles paper expressly demands giving priority to safety as part of the corporate policy. The implementation of the management system described there ensures the necessary approaches to reach this business objective. In addition, the management system particularly serves to strengthen the safety culture.

Implementation and measures by the plant operators

Safety policy

All German companies operating nuclear power plants committed themselves management principles or corporate policies to give priority to the safety of the nuclear power plants over all other business objectives (→ Article 9). For the implementation of these principles, both the respective management system and measures for the safety-directed behaviour of the personnel - keyword “safety culture" -, have continuously been further developed.

Safety management

In mid 2008, the German plant operators submitted the VGB guideline “VGB-Leitfaden zum Sicherheitsmanagement” on safety management. The guideline is based on the concept on the optimisation of the safety management system (“Konzept zur Optimierung des Sicherheitsmanagement-Systems”). The guideline supplements and specifies the concept of 1999/2002 regarding the improvement of the safety level in the German nuclear power plants, the description of the principles and objectives of a safety management system (SMS) and the requirements arising for an SMS to ensure high safety. It takes into account the national and international developments and findings in recent years in the field of management systems and therefore is a basis for the German nuclear power plants for further developing their management systems.

Regulatory review

Priority to safety is also applied as basic principle for the work of the nuclear authorities of the Federation and the *Länder*. This principle is implemented in the task descriptions of the supervisory and licensing authorities and is concretised in supervisory practice.

Within the framework of licensing of a nuclear power plant and within the framework of supervision of plant operation, the authority checks which provisions are implemented by the applicant to fulfil his responsibility for the safe operation of the plant (→ Article 9) and to give priority to safety.

Supervision by the *Länder* is structured systematically according to the different fields of supervision (e.g. maintenance, in-service inspections, radiation protection). The regular evaluation of the findings from supervisory procedures allows that the *Länder* can organise their supervision by, e.g., additional inspections in case of indications, such that safety-relevant issues are given due attention.

In meetings with the managing personnel of the licensee, the supervisory authority satisfies itself that priority is given to the safe operation of the plant at the strategy level. In this respect, the statements and the behaviour of the managing personnel of the plant operator (top management) are of particular importance.

The supervisory authorities obtain information about the safety-directed behaviour of the operating personnel of the plant operator e.g. by extensive controls during on-site inspections and the evaluation of reportable events and other occurrences (→ Article 19 (vii)).

Within the framework of accompanying reviews of the supervisory authorities on introduction and application of the management systems of the plant operators it is checked, among others, whether and how priority to safety is anchored in the basic principles of the management system. Some *Länder* also review the effectiveness of the management system. In addition to the basic principles, the focus of supervision is on those processes in which priority to safety becomes particularly evident (e.g. company objectives, management review).

The safety culture assessment system (VGB-SBS) is a tool for self-assessment applied by the plant operators of the nuclear power plants. The VGB-SBS is an element of the safety culture programme and also serves, according to the users, to review the effectiveness of the management system. The supervisory authorities of the *Länder* informed themselves about the methods and proceedings of the plant operators. The supervisory authorities are informed about the performance and main results of the VGB-SBS.

In addition, some authorities of the *Länder* use indicators in order to get a picture of the safety performance of the plant operator and to align their activities accordingly. These safety performance indicators are partly specified by the licensees or by the authorised expert and reported to the authorities. The other part of the indicators is specified by the authorities themselves. The nuclear supervisory authority of the *Land* of Baden-Württemberg, for example, currently uses a set of indicators of about 70 safety performance indicators. The evaluations of these and other indicators are discussed with the plant operator together with other findings from supervision and this way referred to for assessing the safety management system of the plant operator.

The overall objective of the use of these indicators is to signal changes as early as possible in terms of an early warning system. The causes of such changes can usually not be derived from the indicators themselves.

To this end it is required to investigate the cause of changes in meetings with the plant operators or by detailed analyses.

Internal measures of the authority for priority of safety

The authorities and their staff are bound by the legal provisions. These clearly state: The protection of man and the environment against the hazards of nuclear energy and the harmful effects of ionising radiation – and thus the safety of the nuclear installations – are given top priority.

Moreover, the nuclear authorities set up guiding principles or overall concepts towards which their actions are oriented. These further concretise the principle of priority to safety. The objectives of the nuclear authorities are aimed at improving the safety of the nuclear power plants and improving the monitoring of safety. The use of internal resources and the scope of support by the authorised experts are oriented towards the safety significance of the tasks and issues to be clarified.

Article 10: Progress and changes since 2007

In the last years, the management systems of the nuclear power plants have been further developed. In addition to the structural organisation, the procedural organisation was documented in a process-based manner in supplement to the already existing written operating procedures. Sets of indicators that take into account the international standard and the process assessment have been introduced and further developed.

The exchange of experience within the frame of the VGB has resulted in that the licensees largely follow a process-oriented approach for the management systems. In addition to the management processes it also covers the safety-relevant operating processes. This was already demanded by the by the Federal Environment Ministry in a principles paper [3-81] in June 2004. In safety standard [KTA 1402], currently being developed, the requirements on the management system are to be further specified.

Using the results of reviews, audits and evaluation of indicators, the supervisory authority is able to evaluate the effectiveness of the safety management system for each facility and to recognise the progress made towards the achievement and the development of safety objectives.

Article 10: Future activities

The further development and optimisation of the safety management system based on the results of effectiveness reviews are an ongoing task for the operator. This process will also continue to be monitored within the framework of the supervisory procedure of the *Länder*.

In this respect, the following aspects are to be considered:

- Verifications and regular reporting on the fulfilment of the requirements resulting from the current state of the art in science and technology for the introduction, application and improvement of their management systems,
- methods and reliability of the effectiveness review practised by the licensees (derivation from the safety objectives, indicators, independent internal or external checks (as for example management reviews and audits), systematic comparison with other plants and plant operators (as for example peer reviews, benchmarking)),
- methods of the regular regulatory verification on the establishment and application of management systems, giving due priority to nuclear safety, by the licensees including issues relating to the interactions and potential reciprocal effects of the effectiveness review by the licensee and the supervisory authority. An international comparison of regulatory requirements for the safety management and the resulting measures is to be made within the supervisory process to ensure the compliance of the national requirements with the state of the art in science and technology.

For revision of safety standard [KTA 1402], see also Article 19.

The introduction of the process-oriented management system will be finalised in all plants.

According to Article 6 para 4 of Council Directive 2009/71/EURATOM of 25 June 2009 [1F-1.25] establishing a Community framework for the nuclear safety of nuclear installations, the member states shall ensure that the national framework in place requires licence holders to establish and implement management systems which give due priority to nuclear safety and are regularly verified by the competent regulatory authority.

Council Directive 2009/71/EURATOM shall be implemented by the EU member states by 22 July 2011. The contents of the Directive have not yet been fully transposed into the relevant legal and administrative provisions of the Federation and the *Länder*. In co-operation with the licensing and supervisory authorities of the *Länder*, the Federal Government examines to what extent the legislative, regulatory and organisational framework is to be changed at the federal or *Länder* level.

11 Financial means and human resources

ARTICLE 11 FINANCIAL AND HUMAN RESOURCES

1. Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.

2. Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety-related activities in or for each nuclear installation, throughout its life.

11 (1) Financial means

Legal and regulatory requirements

According to Section 7 para 2 of the Atomic Energy Act [1A-3], a licence for the construction, operation or essential modification of a nuclear power plant may only be granted if, among others, there are no known facts giving rise to doubts as to the reliability of the applicant and the necessary precautions have been taken in the light of the state of the art in science and technology to prevent damage resulting from the construction and operation of the installation. The licensing prerequisite of reliability also includes the necessary financial capacity and the economic credibility of the applicant. The provision of the necessary resources is thus a prerequisite for ensuring the necessary precautions against damage in accordance with the state of the art in science and technology. The required reliability and precaution against damage are also criteria for supervision during operation (→ Article 7 (2) (iii)). According to Section 17 of the Atomic Energy Act, the authority may revoke the licence if the licensing prerequisites are no longer fulfilled at a later point in time and cannot be fulfilled within a reasonable time.

According to Section 33 para 1 sentence 1 of the Radiation Protection Ordinance [1A-8], it is a duty of the radiation protection supervisor to “assure ... particularly by the provision of suitable rooms, equipment and appliances, by appropriate control of operational modes and by provision of adequate and suitable staff” that provisions, as e. g. licences, are observed. Thus, the requirement of provision of the necessary financial means is implicitly derived from the duties of the radiation protection supervisor.

In order to be prepared for the follow-up costs connected with the operation of a nuclear power plant, the plant operators are obliged pursuant to the commercial law to build up financial reserves during the plant’s operating life for the decommissioning of the installations, and the treatment and disposal of radioactive wastes including spent fuel elements. For providing financial security for the exploration and construction of facilities for the disposal of radioactive wastes, the Federal Office for Radiation Protection collects advance payments for expenses for the exploration and construction to be finally made according to the Waste Disposal Advance Payments Ordinance [1A-13].

Implementation and measures by the plant operators

The nuclear power plants in operation in Germany are run by private corporate enterprises. These are subsidiaries of large power utilities and financially stable. Within the framework of management principles and mission statements, the utilities committed themselves to maintain a high safety level, to perform backfitting measures and to provide sufficient financial resources.

Consequentially, the German operators make extensive investments to maintain and further enhance the safety level of their nuclear power plants. Further modernisation measures are planned to be performed in all nuclear power plants (→ Articles 14 and 18).

To cover the follow-up costs resulting from plant operation, the operators have to build up financial reserves for the decommissioning and disposal of the plants which are adjusted on an annual basis. The valuation of these reserves is regularly reviewed by independent accountants and the financial authorities.

Regulatory review

Within the framework of licensing of a nuclear power plant, the licensing authority examines whether safe operation is to be expected due to appropriate financial means of the applicant.

The change of operator of an installation subject to licensing, e.g. in case of sale of the plant to another company, requires licensing pursuant to Section 7 of the Atomic Energy Act. The changes in the legal form of the company subject to licensing also include those that may have an influence on the financial means of the licensee. Such licences have been granted within the frame of company law changes for the German power utilities.

The operation of a nuclear power plant is subject to the continuous supervision by the authority. Should the regulatory supervision reveal that investments important with regard to safety have not been made, the authority may order measures to be taken.

11 (2) Human resources

Legal and regulatory requirements

According to Section 33 of the Radiation Protection Ordinance [1A-8], the duties of the radiation protection supervisor also comprise demanding the provision of adequate and suitable staff (→ Article 11(1)).

The required qualification of the personnel responsible for the construction and operation is a licensing prerequisite according to Section 7 of the Atomic Energy Act and thus also to be fulfilled as prerequisite for operation in the long run. Likewise, the personnel otherwise engaged during operation must have the necessary knowledge with respect to safe operation, possible risks, and relevant protection measures to be applied. Accordingly, proof of the qualification of the responsible personnel as well as of the necessary knowledge of the personnel otherwise engaged during operation must already be included in the licence application for construction, operation or essential modifications [1A-10].

Detailed requirements for the technical qualification of the responsible personnel are specified in guideline [3-2] and for the specific knowledge of the personnel otherwise engaged in guideline [3-27]. As responsible personnel, guideline [3-2] describes the following functions:

- plant manager,
- head of department or section,
- responsible shift personnel,
- training manager,
- head of quality assurance,
- radiation protection officer,

- nuclear safety officer, and
- physical protection officer.

The above mentioned guidelines [3-2] and [3-27] are supplemented by the guidelines on the certification of the qualification of responsible shift personnel, on the maintenance of qualification of responsible shift personnel, and on the specific qualification of personnel responsible for radiation protection [3-38], [3-39], [3-40], [3-61], [3-65]. These guidelines specify the task-related initial qualification, additional training requirements, performance of training and the acquisition of practical experience required for the technical personnel, and furthermore, for the responsible shift personnel, the examinations and certification required in their respective responsibilities. Simulator training is part of the education for shift supervisors, their deputies and reactor operators required according to guideline [3-2].

When using external personnel, the applicant has to make sure that the necessary knowledge is ensured according to guideline [3-27] and, where required, by persons in support of them. This also applies to the case that knowledge is communicated by the contractor. This is to be demonstrated to the supervisory authority upon request.

Methods for establishing competence requirements and training

<u>Personnel development</u>

German nuclear power plants currently in operation are staffed with personnel which has a long experience in the operation of nuclear power plants. In addition to own plant personnel, use is also made of external personnel. On average, about 350 own plant employees and about 150 employees of contractors are employed all year round per unit. During plant outage for refuelling and annual inspection, the number of external personnel is increased to 1000 employees approximately.

The demographic change and the generational change at the nuclear power plants have an influence on the personnel structure of the nuclear power plants. Figure 11-1 shows the age distribution of personnel at a site with double-unit plant and is comparable with the situation at other sites.

Due to the demographic personnel development, a forward-looking personnel management is implemented for maintenance of competence and the number of personnel. On the basis of the expected retirements, as well as statistical forecasts, the plant operators typically plan the need of replacement recruitment up to five years in advance. The replacement plans consider both necessary lead times for training and know-how transfers in case of new recruitments.

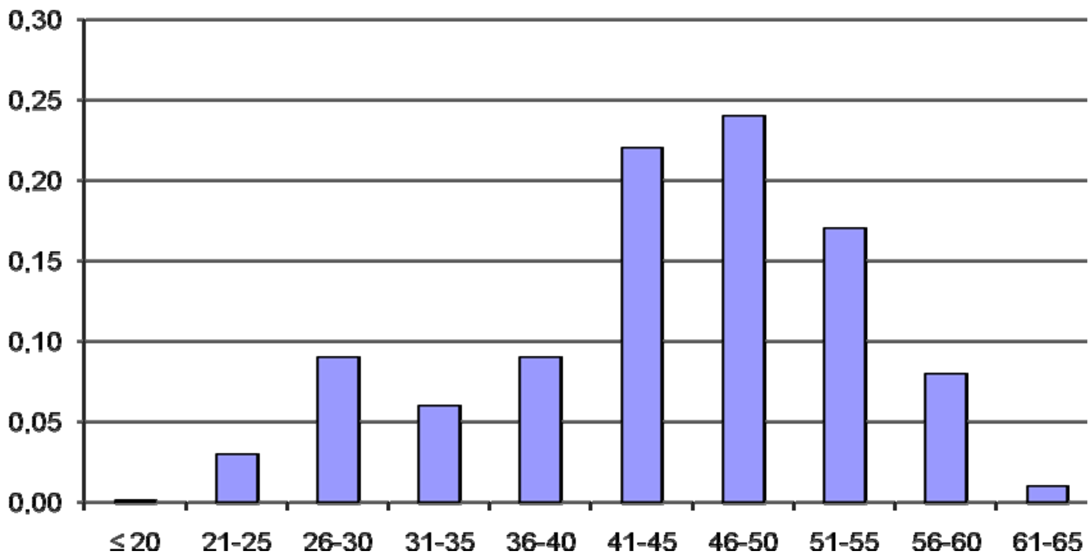


Figure 11-1 Age distribution of personnel with technical know-how at the Biblis site

An equally important issue of personnel development at the nuclear power plants is the succession management. This also includes, among others, that adequate successors are identified and promoted by assessing their potential. This way, leadership positions that become vacant can be filled with staff best suited for the position in due time. The preparation for taking over of such positions is performed by appropriate training.

The maintenance of competence for and the know-how transfer within specialist positions that need to be restaffed due to retirements or for which more staff is required, takes place through systematic training programmes as well as a long-running "parallel recruitment". Here, the young staff accompanies the experienced staff at the specialist position assigned to him up to three years depending on the tasks.

Further, continuous promotion of junior staff takes place by intensive co-operation of the plant operators with the universities and the nuclear research institutions which comprises the promotion of professorships in the field of nuclear engineering, funding of doctoral studies as well as professional practical training and courses for students.

Personnel qualification

The German public vocational training system provides excellent conditions to ensure that the operating organisations of nuclear power plants can find skilled workers, foremen, technicians, engineers and scientists who received relevant technical basic training within their schooling and vocational training that is documented by a state-approved certificate. To supplement the public vocational training system, in 1970 the utilities founded a power plant training centre to correspond to the requirements regarding the specific skills of the nuclear power plant personnel.

Due to the high self-imposed quality criteria of the operators for the staff, the plant operators invest on average across the plant staff several man-days in training per year and staff member. Due to the high demand for training, there is an own training concept for each plant. This is generally implemented with highly qualified and experienced shift supervisors who organise the training programmes and, in parts, also carry them out themselves. Where necessary, specialists within the technical departments or external specialists, e.g. from universities, plant manufacturers or the Simulator Centre (→ Simulator training), will be involved. The quality of the training concept is maintained by a lively co-operation with the technical departments and the Simulator Centre.

The concrete requirements on the qualification of nuclear power plant personnel belonging to responsible personnel or otherwise engaged personnel according to guidelines [3-2] and [3-27] are specified in the training manuals of the nuclear power plants. They also document the measures for acquisition, maintenance and verification of the technical qualification. So, e.g., the responsible shift personnel must have passed the examination of technical qualification by the time they first act in the respective function. The measures regarding control of success and documentation of the training performed are also part of the training manual.

Simulator training

Plant-specific full-scope simulators are available for all nuclear power plants. Simulator training is an essential part of the programmes for the maintenance of technical qualification. The training is regularly adapted to new findings and technical facts. The training deals, among others, also with methods for coping with stress situations and communication. Particular attention is being paid to the feedback of operating experience.

The Simulator Centre trains the responsible operating personnel of almost all German nuclear power plants. For operational purposes, two companies were founded in 1987:

- GfS Gesellschaft für Simulatorschulung mbH for carrying out the training courses,
- KSG Kraftwerkssimulator-Gesellschaft mbH for the provision of the simulators and other infrastructure.

Every year, the courses at the Simulator Centre are attended by over 2,000 participants from 17 nuclear power plants. In 500 to 600 courses, these learn to operate and understand their nuclear power plants under all conceivable operating conditions on 13 simulators (9 PWRs (another one under construction), 4 BWRs). This makes the KSG|GfS Simulator Centre the world's largest facility of its kind.

The simulators exactly reproduce the referenced nuclear power plant in appearance and also in its technical, physical and temporal behaviour. The operating personnel encounter the same working conditions and requirements as they would or could occur in reality when operating and monitoring their plant.

The training programmes contain the entire range of nuclear power plant operation: normal operation, operational disturbances as well as all incidents and accidents in any combination and under widely differing boundary conditions. Training places equal emphasis on operating and understanding the technology as well as on human performance in the team: ability to work in a team, communication, decision-making and leadership.

Qualification of external personnel

The requirements for otherwise engaged personnel from above-mentioned guidelines also apply to external personnel. In accordance with the respective duties, occupational qualification, practical experience and certification of knowledge are already required within the commissioning procedure. In addition, special instructions are given at the nuclear power plants. Here, plant-specific knowledge is imparted, at least in the fields of radiation protection, fire protection, industrial safety, as well as plant organisational structure and procedures. For persons in special positions (e.g. radiation protection planner, person responsible for the performance of the work), additional training is required.

Further development of the training programmes

The technical personnel - during initial training and repeatedly during advanced training - is regularly made aware of the importance of safety-oriented actions (→ Article 10). By means of practical examples (findings from the evaluation of operating experience), the particular importance of safety-oriented actions is concretised.

The training programmes at the Simulator Centre are continuously being supplemented by means of the experiences gained from power plant operation and analyses. To this end events are used, in particular, that indicate deficiencies in the technical qualification or in the performance of the plant personnel that is not safety oriented.

The trainers of the Simulator Centre participate in comprehensive further training and regularly visit the plants to gain practical experience.

Methods for verifying the provision of a sufficient number of qualified personnel

Within the framework of licensing of a nuclear power plant, it has to be verified to the licensing authority by the plant operator that a sufficient number of qualified personnel is provided for plant operation. The verifications of the plant operator are carried out on the basis of the relevant guidelines, in particular [3-2] [3-27] and reviewed by the authority within the framework of the licensing procedure.

The supervisory authority gathers information about the long-term human resources planning of the plant operator. Essential changes in the number of personnel of the plant operator which might negatively influence the safe operation are subject to licensing and review by the competent authority.

Review of subcontractors

In Germany, the review of the subcontractors lies within the responsibility of the plant operators (→ Article 13).

Experts in the field of nuclear technology

A detailed description is given in Article 19 (v).

Regulatory review

The measures of the plant operator to ensure adequate staffing are reviewed by the supervisory authority on the basis of reports submitted. Through discussions with the plant operators and controls in the plants, individual aspects of recruitment, personnel development and staffing are reviewed and evaluated in depth.

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

The responsible shift personnel (shift supervisors, deputy shift supervisors and reactor operators) must additionally have passed the examination of technical qualification by the time they first act with responsibility in the respective function [3-39].

After the written examination, the plant operator submits, among others, the result of the written examination and a compilation of the other proofs of technical qualification. Members of the examination board for the oral examination with a vote are, in addition to representatives of the plant operator, representatives of the supervisory authority and their experts consulted. The supervisory authority makes a written decision about the admission to the intended function as soon as the candidate has passed the examination and has met all other prerequisites.

For the otherwise engaged personnel it has to be verified that they have the necessary knowledge concerning the safe operation of the installation, of the possible hazards and of the protective measures to be taken as far as this knowledge is required for the proper performance of the tasks and for the protection of the person itself. This is verified by random inspections within the framework of regulatory supervision.

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

Article 11: Progress and changes since 2007

The general duties of the plant operators and the competent authorities according to the regulatory requirements in terms of a continuously improving safety culture and in terms of the requirements of the Convention are a guide for action and measures.

The requirements in [3-2, see note] for measures to maintain technical competence of the nuclear power plant management personnel were defined precisely and have been implemented.

The power plant operators organised in the VGB are currently developing a guideline with recommendations on the control of learning success. The introduction of the systematic, process-oriented reorganisation of training will take place on the basis of this guideline in accordance with the cycle process "Systematic Approach to Training" (SAT) recommended by the IAEA. This cycle process is based on fundamental elements of a quality management system. For going through the individual process steps, success and effectiveness controls are prescribed at selected distinct points. The completion and success of a training course will be evaluated in several ways to be able to assess, on the one hand, the effectiveness and, on the other hand, the quality of a training and advanced training event and, where possible, to show potential for improvement.

For more structure and, above all, better traceability of these steps, a plant operators' working group is currently formulating a guideline on behalf of the VGB that draws up appropriate recommendations and boundary conditions for implementation. The main objective of the guideline is to make the cycle process according to SAT transparent and functional.

The work on VGB recommendations on learning success control (guideline) was initiated by the Working Panel "Nuclear Engineering Training" and is supported by the VGB Technical Committee "Nuclear Power Plant Operation". Completion is targeted for 2010.

Article 11: Future activities

Guideline [3-2] relating to the proof of the technical qualification of nuclear power plant personnel which, among others, contains concrete requirements for the technical qualification of responsible personnel, is currently being revised. This includes, in particular, the adjustment of the times required according to practical experiences.

12 Human factors

ARTICLE 12 HUMAN FACTORS

Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.

Legal and regulatory requirements

The Safety Criteria for Nuclear Power Plants [3-1] stipulate that high requirements have to be imposed on the design and quality of the nuclear installations. Further, safety-enhancing operating principles are to be realised. These general requirements include, among others,

- ease of maintenance of the systems and plant components under special consideration of possible radiation exposure of the personnel,
- ergonomic measures at the workplaces, and
- reliable monitoring of the operating conditions.

Criterion 2.5 of the Safety Criteria for Nuclear Power Plants [3-1] requires that workplaces and work procedures are to be designed under ergonomic aspects in such a way that they create the prerequisites for the personnel's optimal performance in terms of safety.

The Safety Criteria [3-1] are specified by further general rules, guidelines and KTA safety standards:

- Safety standard [KTA 3501] requires that necessary manual initiations of safety devices for controlling incidents are not required before a time span of 30 minutes. This requirement has considerable influence on the automation of triggering of safety devices, the man-machine interface and the design of the control room.
- The general procedure of maintenance measures is described in the guideline for the procedure for preparation and performance of maintenance and modifications at nuclear power plants [3-41] under special consideration of human factors.
- Safety standard [KTA 1201] includes the requirements on the operating manual. Safety standard [KTA 1202] includes the requirements for the testing manual.
- Safety standard [KTA 3904] makes requirements on control room, emergency control room and local control stations in nuclear power plants.

In 2008, the Reactor Safety Commission (RSK) adopted two recommendations related to human actions in nuclear power plants: recommendation "Guideline for the performance of integrated event analyses" at its 411th meeting (14./15.10.2008) and recommendation "Requirements on the determination of the minimum shift staffing at nuclear power plants to ensure safe operational management" at its 417th meeting (18.06.2009).

An "integrated event analysis" is a comprehensive study of an event to be analysed by an analysis team. In a systematic approach, event sequence and, as far as possible, all the factors contributing to the event are identified. "Integrated" means that all contributing factors from the areas of man, technology and organisation and their interactions are taken into account. "Integrated event analyses" prompt the staff to carry out considerations that are not event specific. With this analysis method, appropriate measures can be derived which are to prevent a recurrence or occurrence of similar events.

In German nuclear power plants, the plant operators carry out integrated event analyses according to the applicable VGB guideline “Leitfaden Ganzheitliche Ereignisanalyse“ on integrated event analyses as of 6/2003.

If defined selection criteria are fulfilled, as far as they are of significance for the event sequence, the method is applied, as e.g. in case of

- incidents,
- abnormal operating conditions,
- significant transients,
- unscheduled unavailability of components with safety-relevant functions,
- significant personal injuries,
- significant component or material damages,
- drop of loads,
- unscheduled discharge and release of radioactive material from the plant,
- significant, unscheduled release of radioactive material within the plant,
- contamination,
- significant occurrences during fuel element handling,
- significant occurrences not having initiated events but that are related to human actions or organisational/administrative impacts,
- occurrences involving hazards to persons,
- knowledge of non-compliance with operating procedures,
- knowledge of incomplete, incorrect or missing operating instructions that my impair safe operation of the plant,
- significant occurrences during maintenance processes,
- accumulation of similar events.

Regarding the analysis method for the integrated event analyses, a basic analysis is carried out.

The basic analysis comprises, e.g., the following steps:

- Collection of information and data,
- description of the event and event progression,
- first evaluation and decision on immediate measures,
- event analysis and assessment,
- safety and availability assessments,
- assessment of the obligation to report according to the Nuclear Safety Officer and Reporting Ordinance,
- identification of causes,
- derivation of remedial measures,
- preparation of a basis analysis report.

An in-depth analysis in terms of the integrated event analysis will be performed if the basic analysis reveals undesired interactions between technical, organisational and human factors and if the causes could not be adequately determined.

The in-depth analysis includes, e.g.,

- break-down of the entire event sequence into individual events of the cause-and-effect chain by means of a time-actor diagram,
- analysis of the individual events and assessment of the contributing factors,
- derivation of remedial measures,
- analysis report – summary of the results.

The implementation of the remedial measures is monitored internally. Effectiveness control is ensured by the safety management system of the plants.

Within the framework of the exchange of experience among the plant operators in the VGB Working Panel "Nuclear Safety Officers and Human Factors", analysis results are presented and discussed. This shows that the analysis method is suitable to identify causes and to derive effective remedial measures. Nevertheless, the VGB working panel identified possibilities to optimise the guideline.

In order to integrate aspects of the RSK recommendation "Guideline for the performance of integrated event analyses" and findings from the VGB working panel, it is intended to revise the existing VGB guideline.

Regarding the minimum shift and minimum control room staffing the RSK recommends a plant-specific analysis. The basis for determining the minimum shift staffing are all tasks of the operating personnel stated in the operating documents, such as operating manual, accident management manual, testing manual, shift instructions, etc. For the analysis, covering event sequences can be referred to. The analyses for determining the minimum shift staffing are to be documented in a traceable manner.

When determining the minimum shift staffing, it is to be ensured that both for safe specified normal operation including low-power and shutdown operation and for the control of events of levels of defence 3 and 4, adequately qualified operating personnel will be available in the plant until certain arrival of reinforcement personnel. Personnel on stand-by or of the emergency organisation may be taken into account for verification if it will be operational in time. The minimum shift staffing for controlling events of safety level 3 requires the following:

- One shift supervisor, in particular for the analysis of the event, determination of the strategy for handling the design basis accident and related operating modes, management and co-ordination of the shift team and other organisational units involved in handling the design basis accident, as well as initiation or ordering of the necessary information and communication tasks.
- One deputy shift supervisor, in particular for continuous monitoring of the processes and the switching operations, success control and monitoring of protection goals.
- One reactor operator for monitoring and operation of the reactor and its safety installations.
- One control panel operator for operation of the feedwater/steam circuit systems, the supporting systems, etc.
- One electrician with switching authorisation for all electrical installations in the area of the control room/switchgear building for the assessment of electrical faults and, where required determination of appropriate immediate measures in co-operation with the shift supervisor, an operation of the electrical installations.
- Two shift workers for the performance of switching operations and controls of mechanical equipment in the plant.

- One shift electrician for servicing on-site electrical installations, such as emergency power facilities, and for carrying out switching/isolating operations in the switchgear building and in ancillary electrical installations.

In addition to the determination of a minimum shift staffing, determination of the minimum control room staffing is required. For the performance of tasks for monitoring and operation of the plant, the control room should be permanently staffed with at least one shift supervisor or deputy shift supervisor and a reactor operator.

Consideration of ergonomic principles in the design and modifications of nuclear installations

This aspect is dealt with under Article 18 (iii).

Implementation and measures by the plant operators

The nuclear power plants are controlled and operated from a central control room. The control room is equipped with all the information, operation and communication systems that are necessary for normal operation and for coping with abnormal operation and design basis accidents. For the design of the control room, great importance was attached to ergonomic aspects.

German nuclear power plants are highly automated. In addition to the extensive instrumentation and control systems available for operation, many complex switching operations are activated by automatic controls. This relieves the personnel from routine actions and it will be able to concentrate on the monitoring of the safety-relevant processes and process parameters.

The concept of the reactor protection system design includes the automatic control of design basis accidents for a period of at least 30 minutes without the need for any manual action. In the case of abnormal operation or design basis accidents, the aim of this concept is to ensure sufficient time to diagnose the situation and take appropriate actions. If necessary, manual actions can also be performed within the specified 30 minutes, e.g. actuation of reactor scram.

Computerised information systems support the operating personnel in all nuclear power plants. With regard to maintenance, especially as concerns in-service inspections, extensive technical measures are provided to prevent human errors or to minimise their effects. These measures range from permanently installed and unambiguously identifiable testing devices to testing computers and the automatic resetting of safety systems in the event of their inadvertent actuation by the reactor protection system in the course of an in-service inspection.

On 28 June 2007, there was a fire in one of the two transformers in the Krümmel nuclear power plant [INES 0] (→ Article 6). The analysis of the event sequences showed that audio recordings may contribute to an improved evaluation of events. The technology is currently being installed. The modalities of use are being discussed between the licensing authority and the plant operator.

In addition to technical measures, personnel and organisational measures have also been investigated and implemented. The analyses and measures comprised, among others,

- the communication at the control room during the event with the recommendation to implement the so-called “markers” for successful work at the control room and, in addition, to introduce the three-way communication for ordering switching operations,
- the optimisation of the processes regulated in the die operating manual, as well as
- the limitation of the number of personnel at the control room, and
- the introduction of a new alarm category with the aim to ensure the necessary support without having to trigger emergency alarm.

Self-assessment of management and organisation by the plant operator

This aspect is dealt with in Article 10.

Evaluation of operating experience with regard to human and organisational factors

This aspect is dealt with in 19 (vi).

Regulatory review

The fulfilment of the requirements on the man-machine interface is checked by the licensing authority in the licensing procedures for construction and operation of the plant according to the requirements of the rules and regulations. To this end, the proofs submitted by the applicants, e.g. by the plant operators, were subjected to extensive reviews by the authority. Modifications of safety-relevant plant components and written operating procedures require licensing by the authority and are thus subject to comprehensive regulatory review within the framework of the modification procedure. For the assessment of reportable events and other occurrences, the authority also considers the contributing factors from the areas man and organisation.

The concept of the plant operators on an “integrated event analysis” was reviewed for its suitability by the *Länder* authorities within the framework of their supervisory activities. The main aim of this analysis is to ensure that the operator analyses the events in an integrated manner under consideration of all contributing factors from the areas of man, technology and organisation and derives remedial measures with regard to these factors. The plant operators give report to the supervisory authority on the application, results and effectiveness of their integrated event analysis. Moreover, the supervisory authority reviews the methods of the plant operator for the analysis of events and experience feedback in technical meetings. A basis for review offer the requirements stated in the RSK recommendation “Guideline for the performance of integrated event analyses”.

In individual cases, the supervisory authority requires the performance of additional independent event analyses for in-depth assessment of contributing factors from the fields of man and organisation.

Article 12: Progress and changes since 2007

In 2008, the Reactor Safety Commission (RSK) adopted two recommendations related to human actions in nuclear power plants: recommendation “Guideline for the performance of integrated event analyses” at its 411th meeting (14./15.10.2008) and recommendation “Requirements on the determination of the minimum shift staffing at nuclear power plants to ensure safe operational management” at its 417th meeting (18.06.2009).

Article 12: Future activities

On the basis of the above RSK recommendations and the more specific consultations on the communication at the control room and its recordings as well as the supervisory review of the operators’ safety culture, the following activities are planned for the next years:

– Further investigations into audio recordings at the power plant control room,
– development of standardised national criteria for procedures regarding the regulatory review of the safety culture.

13 Quality assurance

ARTICLE 13 QUALITY ASSURANCE

Each Contracting Party shall take the appropriate steps to ensure that quality assurance programmes are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the life of a nuclear installation.

Legal and regulatory requirements

All operators of German nuclear power plants are obliged to perform comprehensive quality management. To this end, appropriate quality assurance systems are applied in all nuclear power plants that, so far, are based on the provisions for quality assurance specified in the Safety Criteria [3-1] and in the KTA nuclear safety standards.

In the Safety Criteria for Nuclear Power Plants [3-1], individual specific requirements for quality assurance were formulated.

Quality and reliability of all facilities of a nuclear power plant are to be taken into consideration within the framework of the technical concept according to their safety significance.

The general requirements regarding quality assurance are contained in safety standard [KTA 1401]:

- The objective of quality assurance is to ensure in a documented way that the quality requirements are specified for product forms, component parts, components, and systems, and are fulfilled during manufacture and installation and also during the erection of civil structures. Furthermore, it has to be ensured that the respective requirements continue to be fulfilled under the conditions of operation and maintenance up to the decommissioning of the nuclear power plant.
- The plant operator is responsible for the planning, implementation and supervision of the effectiveness of his quality assurance system. It is, therefore, also within his responsibility to assure that his contractors and their sub-contractors plan and implement their quality assurance in accordance with his own quality assurance system.

Safety standard [KTA 1401] is currently being updated.

Implementation of an integrated management system

Main objective of the integrated management system is to also integrate requirements from other company perspectives, in addition to nuclear safety, into the management system. Such an integrated management system is required to ensure that in case of competing demands and objectives, those of nuclear safety are given priority according to their significance.

All German operators of nuclear power plants have implemented comprehensive quality assurance programmes on the basis of the provisions for quality assurance specified in the Safety Criteria and in the KTA nuclear safety standards.

By the high quality of plant operation systems, a sound and environmentally compatible operation is to be achieved and accidents to be prevented.

The concrete implementation of the requirements from safety standard [KTA 1401] and the Safety Criteria [3-1] is described in plant-specific documents (e.g. QM framework descriptions). These documents determine how and by whom the quality requirements necessary for safety have to be specified, how and by whom they have to be fulfilled, and how and by whom their fulfilment is to be verified. Procedures are described for the initiation of corrective measures in case of non-compliance with the quality requirements. Furthermore, the structure of the organisation implemented for quality assurance is described and reference is made to work procedures to perform quality assurance.

Audit programmes of the plant operator

Quality assurance is independently performed by the plant operator within the framework of his responsibility for the safety of his plant.

With the introduction of ISO 9001:2000 and the associated discussion about management systems, e.g. including safety management, the plant operators improved quality assurance to become a process-oriented and thus adaptive quality management. Some nuclear power plants have their quality management system already certified according to ISO 9001 by independent auditors.

Introduction and review of the quality management system is performed at each nuclear power plant by an independent staff unit. This staff unit, with the quality management officer, is authorised to have access to all relevant information, make proposals for the elimination of quality deficiencies, and monitor compliance with the quality assurance measures.

In exercising their responsibility for safe operation, the plant operators regularly review the effectiveness of their QA systems by own internal audits. Audits are typically applied for management systems, for processes or products, including maintenance activities. Examples of results from audits in the past are:

- optimisation of the checklist for the handling of fuel elements;
- improved effectiveness control of training measures;
- optimisation of the supplier reporting system;
- improved collection of component reliability data.

Audit programmes of the plant operators for manufacturers and suppliers

To ensure that contractors for supplies and services, including their subcontractors, plan and implement quality assurance in accordance with the requirements of the quality assurance system of the nuclear power plant, the plant operator checks the contractors under consideration of safety standard [KTA 1401]. In addition, a contractor evaluation is performed for each contract. The information about the contractor are stored in a central database and are available to each nuclear power plant. Any detected gaps and deficiencies are communicated immediately. Remedial actions are initiated.

Regulatory review

As part of their supervisory activities, the supervisory authorities pursue and gather information about the following topics of quality management:

- Results of the internal audits,
- implementation of the measures derived,
- further development of quality management towards an integrated management system,
- certification of the management systems,
- evaluation of indicators, and
- results of the management review.

On the basis of findings obtained by it, the supervisory authority satisfies itself with regard to the effective implementation of the quality assurance system. Moreover, the supervisory authority controls the results of the audits performed by the plant operator and the implementation of measures derived from it within the framework of on-site inspections. Assessments and regulatory requirements refer to the effectiveness of quality assurance. The overall organisational responsibility for an effective quality assurance system remains with the licensee.

Article 13: Progress and changes since 2007

The general duties of the plant operators and the competent authorities according to the regulatory requirements in terms of a continuously improving safety culture and in terms of the requirements of the Convention are a guide for action and measures. Furthermore, no specific measures have been required in the past three years.

Article 13: Future activities

For the further development of quality assurance during operation of a nuclear power plant, safety standard [KTA 1401] is currently being revised.

For revision of safety standard [KTA 1402], see Article 19.

14 Assessment and verification of safety

ARTICLE 14 ASSESSMENT AND VERIFICATION OF SAFETY

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

i) comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life. Such assessments shall be well documented, subsequently updated in the light of operating experience and significant new safety information, and reviewed under the authority of the regulatory body;

ii) verification by analysis, surveillance, testing and inspection is carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions.

14 (i) Assessment of safety

Requirements for safety assessments in licensing and supervisory procedures

According to the Atomic Energy Act [1A-3], a licence for major modifications of installations or their operation may only be granted if

- there are no known facts giving rise to doubts as to the reliability of the application and of 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 requisite qualification,
- it is assured that the persons who are otherwise engaged in the operation of the installation have the necessary knowledge concerning the safe operation of the installation, the possible hazards and the protective measures to be taken,
- the necessary 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,
- the necessary financial security has been provided to comply with the legal liability to pay compensation for damage,
- the necessary protection has been provided against disruptive action or other interference by third parties,
- the choice of the site of the installation does not conflict with overriding public interests, in particular in view of its environmental impacts.

The requirements to be observed when performing comprehensive and systematic safety assessments in licensing and supervisory procedures are included in the “List of Contents and Structure of a Standard Safety Analysis Report for Nuclear Power Plants with Pressurized Water Reactor or Boiling Water Reactor“ [3-5], in the announcement of the “Compilation of Information Required for Review Purposes under Licensing and Supervisory Procedures for Nuclear Power Plants“ [3-7.1], in the guides for the performance of the periodic safety review [3-74.1 – 3-74.3.], and for specific technical aspects and occasions in various regulations of the regulatory guidance instruments in the nuclear sector.

Requirements on the documentation for safety assessments in licensing and supervisory procedures

When applying for a licence for the construction, operation and for essential modifications of a nuclear power plant or its operation, it has to be demonstrated to the competent authority in detail that the licence prerequisites stated in Section 7 (2) of the Atomic Energy Act [1A-3] have been met (→ Article 7 (2ii)). Section 3 of the Nuclear Licensing Procedure Ordinance [1A-10] defines the type and extent of documents to be submitted with an application. This includes in particular, within the framework of construction and commissioning, a safety analysis report which allows a conclusion as to whether the licensing prerequisites have been met, including supplementing plans, technical drawings, and descriptions of the nuclear installation and its parts. Thus, the safety analysis report is the basis for the safety assessment of the nuclear power plant.

According to [3-5], the safety analysis report has to describe the actual and potential impacts of the installations and the precautionary measures provided to be taken into consideration for the decision on the licence application. In this respect, third parties shall have the possibility to assess whether their rights could be violated by the nuclear installation and the impacts associated with its operation. The safety analysis report has to describe the safety concept, all hazards associated with the nuclear installation and the safety-related measures, systems and equipment provided, including the safety-related design features.

Regulatory guideline [3-5] provides a standardised form for safety analysis reports of PWRs and BWRs specifying a detailed outline of the subjects and giving additional information on the contents. The main items of the safety analysis report are

- site,
- the nuclear power plant itself and protection against internal and external impacts,
- organisational structure and responsibilities,
- radioactive material and the corresponding physical protection measures taken,
- operation of the nuclear power plant, and
- analyses of design basis accidents.

Details on the future decommissioning of the nuclear power plant are also required in the safety analysis report. Details on precautions against disruptive action or other interference by third parties are required as part of a separate physical protection report which is classified as confidential.

For demonstrating the fulfilment of the licensing prerequisites and applicable safety requirements, supplementary documents and verifications are required pursuant to the Nuclear Licensing Procedure Ordinance [1A-10]. All documents are subject to regulatory review.

The safety specifications demanded in the Nuclear Licensing Procedure Ordinance [1A-10] and described in the guidelines [3-4] and safety standard [KTA 1201] are to be submitted with the application for licensing of plant operation. They comprise, in particular data and information

- on the organisational structure of operation,
- on provisions important to safety,
- on safety system settings,
- on technical drawings of important components including operating parameters, preceding limits, actuating limits, and design basis values,

- on the general in-service inspection plan for systems and components important to safety, and
- on the treatment of reportable events.

These safety specifications (→ Article 19 (ii)) have to comprise details on all organisational regulations as well as all relevant data, limits and measures which are essential for a safe condition and operation of a nuclear power plant. In particular, those procedures are to be described that are provided to cope with abnormal operation and design basis accidents. The outline plan with specifications for in-service inspection tests provided for safety-relevant plant components is also an integral part of the safety specifications. Any changes with respect to the safety specifications require licensing and, in case of minor safety significance the approval of the supervisory authorities.

All documents prepared or to be prepared for verification purposes according to Section 7 of the Atomic Energy Act [1A-3], including the results of the expert assessments and regulatory assessments, have to be compiled systematically in a safety documentation. The safety documentation is to be prepared and kept up to date by the licensee on the basis of guidelines [3-9.1] and [3-9.2]. The safety documentation includes all technical documents required for verifications in nuclear licensing and supervisory procedures as defined Section 7 para 2 subpara 3 and subpara 5 and Section 19 paras 2 and 3 of the Atomic Energy Act. These are, for example.

- documents on the provisions governing the design, manufacturing, operation and testing of the nuclear installation,
- documents pertaining to safety-related purposes and the mode of functioning of safety-related systems and equipment,
- specifications regarding design, materials, construction and testing as well as specifications concerning maintenance and repairs,
- documents on the results of safety-related measurements and tests including the results from non-destructive and destructive material testing,
- documents on the fulfilment of safety-related specifications, e.g. calculatory demonstrations and design plans or drawings,
- significant safety-related operating records,
- documents pertaining to the radiological protection of personnel and the environment, and
- other documents proving the fulfilment of safety-related specifications, conditions (Section 17 para 1 of the Atomic Energy Act) and directives (Section 19 para 3 of the Atomic Energy Act).

In compliance with the licensing prerequisites, the plant operator has to perform the safety assessments for nuclear power plants under consideration of operating experience and according to the precautions to be taken in the light of the state of the art in science and technology. If required, report is to be made on the results of these assessments and resulting measures in accordance with the requirements of the licence and the specifications in the operating manual.

Safety assessments in the supervisory procedure

Safety assessments are submitted to the supervisory authority upon special request, in the course of licence applications for modifications pursuant to Section 7 of the Atomic Energy Act or modifications subject to approval within the framework of supervision according to Section 19 of the Atomic Energy Act (→ Article 7 (2) (ii)).

The safety review required according to Section 19a of the Atomic Energy Act is dealt with in detail further below.

Safety assessments only taking into consideration a specific section of the nuclear power plant are, e.g., the analyses to be performed for the safety demonstration on the new reactor core after refuelling. Scope and content of these analyses are regulated in the respective licences. In these analyses, the calculation of essential physical parameters and the fulfilment of the safety-related boundary conditions are demonstrated to the supervisory authority with regard to the compliance with the protection goals (→ Article 18 (i)).

Safety assessments are also submitted to the supervisory authority in the course of licence applications for modifications of the plant or its operation pursuant to Section 7 of the Atomic Energy Act or modifications subject to approval within the framework of supervision according to Section 19 of the Atomic Energy Act. The licensing procedure for modifications pursuant to Section 7 of the Atomic Energy Act is basically performed according to the same regulations described above for the granting of a construction licence. This also applies to the documents to be submitted and the safety assessment based on them (→ Article 7 (2ii)). For modifications of the nuclear power plant or its operation not subject to licensing pursuant to Section 7 of the Atomic Energy Act due the negligibility of safety impacts, *Land*-specific regulations are implemented in the supervisory procedures. These regulations specify which types of modifications require prior approval by the supervisory authority and modifications that only have to be reported to the supervisory.

After safety-relevant occurrences at a nuclear power plant, the supervisory authority may require the performance of safety assessments, in particular if measures against recurrence or for improvement of safety are to be taken. Safety assessments may also be required in case of safety-relevant occurrences at other nuclear power plants with regard to their applicability to other plants. Such safety assessments may also lead to measures for the improvement of safety. New findings from plant operation and from science and technology may require an update of safety demonstrations already made.

Safety review

Since the beginning of the 1990s, safety reviews (SRs) have been carried out every 10 years of plant operation according to standardised national criteria. They consist of a deterministic safety status analysis, a probabilistic safety analysis and a deterministic analysis on physical protection of the plant. The SR supplements the continuous review process which is part of regulatory supervision.

The SR results have to be submitted to the supervisory authority and are assessed by independent experts who act by order of the supervisory authority. At the end of the 1980s, the operators of the German nuclear power plants had committed themselves voluntarily to the performance of SRs. For seven nuclear power plants, such an SR was already a mandatory requirement that had been specified in the corresponding operating licence.

The performance of safety reviews (SRs) every ten years is stipulated in the amended version of the Atomic Energy Act of April 2002 (→ Table 14-1). The obligation to present the SR results is lifted if the licensee makes the binding declaration to the licensing and supervisory authority that he is definitively going to terminate power operation at the plant no later than three years after the final date for submission of the SR mentioned in the Atomic Energy Act.

Table 14-1 Safety reviews of the nuclear power plants

(According to Appendix 4, AtG: Safety review pursuant to Section 19a para 1)

	NPP		Type	Date*)
1	Biblis A	KWB A	DWR	31.12.2001
2	Biblis B	KWB B	DWR	31.12.2000
3	Neckarwestheim 1	GKN 1	DWR	31.12.2007
4	Brunsbüttel	KKB	SWR	30.06.2001
5	Isar 1	KKI 1	SWR	31.12.2004
6	Unterweser	KKU	DWR	31.12.2001
7	Philippsburg 1	KKP 1	SWR	31.08.2005
8	Grafenrheinfeld	KKG	DWR	31.10.2008
9	Krümmel	KKK	SWR	30.06.2008
10	Gundremmingen B	KRB B	SWR	31.12.2007
11	Grohnde	KWG	DWR	31.12.2000
12	Gundremmingen C	KRB C	SWR	31.12.2007
13	Philippsburg 2	KKP 2	DWR	31.10.2008
14	Brokdorf	KBR	DWR	31.10.2006
15	Isar 2	KKI 2	DWR	31.12.2009
16	Emsland	KKE	DWR	31.12.2009
17	Neckarwestheim 2	GKN 2	DWR	31.12.2009

*) Date for plants in operation

The performance of the safety reviews of nuclear power plants is to be based on the respective current national guidelines [3-74.1 – 3-74.3] for the deterministic safety status analysis, the probabilistic safety analysis and the deterministic analysis of the status of physical protection. A focal point for the deterministic safety status analysis are the accidents compiled in Appendix A of the guideline [3-74.2] for the deterministic safety status analysis (→ Appendix 3) and a spectrum of beyond design basis plant conditions for which the existence of accident management measures (→ Article 18 (i)) has to be shown.

Deterministic safety status analyses, probabilistic safety analyses and deterministic analyses of the status of physical protection were performed for all 17 operating nuclear power plants and the Stade and Obrigheim nuclear power plants that meanwhile have been shut down.

For the results achieved so far it can be stated that on the basis of the analyses performed, it was demonstrated that the German nuclear power plants fulfil the safety requirements necessary for compliance with the protection goals - in the IAEA standards referred to as fundamental safety functions (→ Article 18 (i)).

Safety assessments performed

<u>Deterministic safety analyses</u>

These analyses have already been dealt with in section “Safety review”.

Probabilistic safety analyses (PSAs)

In the mid-1970s, Germany began to use probabilistic safety analyses in supplement to the deterministic safety assessment. Since the 1970s, the development of probabilistic methods and their exemplary application has mainly been performed by GRS on behalf of the Federal Government.

The methods and data applied for the probabilistic safety analysis are described in supplementary technical documents (methods for the probabilistic safety analysis for nuclear power plants and data for the probabilistic safety analysis for nuclear power plants) [4-7] to the regulatory guidelines [3-74.1 - 3-74.3] and were first published in 1996.

Since 1990, the operators of the German nuclear power plants have performed probabilistic safety analyses for all German nuclear power plants as part of the periodic safety review. Probabilistic safety analyses of Level 1 according to [3-74.1] now exist for all German nuclear power plants. They have led to technical and procedural improvements at the plants.

Since 2005, Level 1 probabilistic safety analyses also comprise low-power and shutdown states, probabilistic analyses for the external events, fire and – depending on the site – also for earthquake, and a Level 2 PSA for power states.

The working group of PSA experts (Facharbeitskreis Probabilistische Sicherheitsanalyse für Kernkraftwerke - FAK PSA) established by the BMU and co-ordinated by the BfS is a committee of independent experts in the field of probabilistic safety analyses. The FAK PSA works out proposals for the updating of technical documents on PSA methods and data according to the established state of knowledge.

Backfitting measures and improvements performed and current activities

The increasing knowledge and requirements imposed on the authorities have led to safety-related backfits and improvements of the plants. Here, findings from the safety reviews were also referred to. Some important measures since 2008 are described in the following.

Impairment of water suction from the containment sump of PWR plants during loss-of-coolant accidents (LOCAs)

During loss-of-coolant accidents with release of insulation material, this may deposit on the sump strainers. In the course of the accident, entrapment of corrosion products and microparticles may lead to a beyond design increase of the pressure losses across the sump strainers already after about 10 hours.

Further, entry into the core and depositions of insulation fibres on the fuel element spacers may occur. Under certain circumstances, these depositions may cause blocking of fuel elements and thus to an impairment of core cooling.

In 2008, the BMU specified requirements for verifications on the basis of the RSK statements of the 374th and 408th meeting of the RSK. Accordingly, measures to control, to limit and to reduce the pressure losses due to depositions on the sump strainers (minimum flow operation and backflushing) are to be provided as part of the accident management. The strainers in the suction area of the emergency core cooling and residual heat removal pumps are to be designed such that core cooling will not be impaired inadmissibly.

In the PWR plants concerned, the following measures have been or are being implemented:

- Reduction of the mesh sizes to 2x2 mm,
- differential pressure measurements on the sump suction strainers,
- reduction of the flow rate or minimum flow operation when reaching limit values,
- backflushing of the sump suction strainers if flow rate reduction or minimum flow operation not sufficient.

The verification requirements for BWRs are based on an RSK statement of 1996. These requirements are currently being revised.

Accident behaviour of fuel elements with cladding tubes made of zirconium-niobium

The German plant operators participate in the OECD CABRI water loop project in France to complete the experimental database for higher burn-ups and for representative cooling conditions of the fuel elements. However, due to delays, first results of the experiments are not expected before 2010. The data expected shall also serve the validation of the computer codes.

Boron dilution

In PWR plants, a loss-of-coolant accident with small leak cross section may lead to the entry of deborated coolant, generated during reflux condenser operation, into the reactor core which results in a decrease of boron concentration in the core and endangerment of subcriticality.

For the core loadings applied, it is to be demonstrated on the basis of conservative boundary conditions that the required minimum margin to criticality of the reactor is maintained.

To improve accuracy of the analysis methods applied, experimental and analytical studies were conducted in the experimental facilities of PKL III and ROCOM or are in progress.

Here, details in connection with the generation and accumulation of deborated coolant and the mixing processes (mixing of deborated and highly borated fluid in the RPV downcomer and in the lower plenum) are of particular importance.

Software-based instrumentation and control (I&C)

At present, software-based I&C is used in German nuclear power plants for functions that are not assigned to the highest safety relevance (i.e. without direct significance for design basis accident control, but being relevant for accident prevention or the control of events of level of defence 4a). These functions are provided, e.g., in the reactor control and limitation system as well as for I&C in second-level emergency systems (→ Article 18 (i)). In few cases, functions of second-level emergency systems are also referred to for the control of accidents related to internal and external events (e.g. fire in the plant, design earthquake).

Software-based I&C in safety systems with the highest reliability requirements for functions to control design basis accidents (e.g. reactor protection) has not been used in German nuclear power plants so far.

The use of software-based I&C has been intensively discussed among all those involved (operators, manufacturers, authorities, independent experts) and in the relevant committee of the Reactor Safety Commission (RSK) under consideration of the international state of knowledge. The focus was on fundamental design requirements for reliability and verification as well as concepts for the realisation of the hardware and software configuration. Specific technical solutions how the safety-related requirements can be fulfilled in particular with regard to the necessary control of the CCF are now to be developed in the context of plant-specific licensing procedures of operators and manufacturers.

In the context of controllability of generally not excludable Common Cause Failures (CCFs), requirements for computer-based I&C are under discussion.

Activities in response to an event in the Krümmel NPP in 2007

As a result of an in-depth evaluation of an event in the Krümmel NPP in 2007 (fire in a transformer [INES 0]), various safety aspects of generic importance were dealt with and discussed in technical committees with regard to improvement measures and considered in actual supervisory procedures. These safety aspects included, in particular, personnel and organisational impacts dealt with Article 12 in detail.

Technical improvements that have been conducted in several German nuclear power plants are precautions to prevent entry of smoke into safety-relevant rooms in case of a fire at the plant site (→ Article 6).

Regulatory review

The assessment of plant safety is continuously reviewed within the framework of regulatory supervision. In case of new safety-relevant findings, the necessity of improvements is determined. Reviews take place in the plants on site and by the examination of documents.

As part of the nuclear supervision by the *Länder*, safety assessments conducted by the plant operator are reviewed both continuously and discontinuously and within the framework of the special periodic safety reviews, and the results achieved by it are implemented. In addition, oversight is performed by the Federation with regard to generic aspects.

For the examination of the documents submitted by the plant operators, the competent licensing and supervisory authority may consult, in accordance with Section 20 of the Atomic Energy Act, independent authorised experts for the review and assessment of specific technical aspects (→ Article 8 (1)). The general requirements for such expert assessments are specified in a regulatory guideline [3-34].

The authorised experts carry out a detailed review and assessment of the documents submitted by the applicant. They perform independent analyses and calculations, preferably with analytical methods and computer codes different from those used by the applicant. The results are evaluated in the expert assessment, which also gives the criteria used in the assessment. The persons participating in the expert assessment are reported by name to the authority.

The licensing and supervisory authorities themselves and subordinate authorities commissioned by them will also carry out own measurements and inspections.

This has been realised, in particular, in the area of emission monitoring of the plants by independent measuring institutions (remote monitoring system for nuclear reactors, Kernreaktor-Fernüberwachung - KFÜ) and by own sampling in the plant environment.

14 (ii) Verification of safety

Regulatory requirements

During plant operation, the provisions of the Atomic Energy Act and the statutory ordinances in pursuance thereof have to be complied with. The orders and directions issued hereunder and thereunder by the supervisory authorities and the terms and conditions of the notice granting the licence or general approval, as well as subsequently imposed obligations have to be adhered to.

With the licence, the licensee is obliged by law to verify regularly by means of in-service inspections that the plant characteristics essential for the safety of the plant and the safety and barrier functions are given and that the quality and effectiveness of the safety-related measures, systems and equipment are ensured. The relevant provisions are included in the licences, in the safety specifications and in the safety documentation.

Detailed requirements for monitoring, recurrent tests and inspections are to be laid down in the operating manual according to safety standard [KTA 1201] and in the testing manual according to safety standard [KTA 1202].

Proceeding of the plant operators in case of doubts about the management and control of design basis accidents

In connection with the evaluation of national operating experience, the Federal Environment Ministry deemed it necessary that the plant operators immediately inform the supervisory authorities if doubts about the management and control of design basis accidents arise due to confirmed scientific and technical knowledge (see previous reports). In this case there is no obligation to report according to the Nuclear Safety Officer and Reporting Ordinance since there is only a doubt. After judicial clarification of specific questions on individual plants, the operators laid down this obligation to inform in the operating manual in addition to the comprehensive information practices.

Routine verification of safety by the plant operator

The responsibility of the nuclear power plant operator requires that the safety of the plant is in compliance with the provisions of the operating licence in force throughout its operating life. Whenever new safety-relevant findings are available, the necessity and adequacy of improvements is to be checked.

To this end, the safety systems are subjected to in-service inspections by the plant operator that are graded according to their individual safety relevance. These in-service inspections include functional tests performed to verify functional performance as well as non-destructive tests to verify faultless condition. Moreover, the plant operator plans and performs regular and preventive maintenance of the plant systems during operation and evaluates the operating experience (→ Article 19 (vii)).

The in-service inspections of systems important to safety are performed in accordance with the requirements specified in the testing manual (→ Article 19 (iii)). The testing schedule contained therein specifies the test object, the nature, extent, and interval of the tests, the operating state of the nuclear installation at which they have to be performed, the identification and name of the test procedure, and which of the tests require the participation of authorised experts. The testing schedule is an integral part of the licensed safety specifications of the nuclear installation. Test performance is specified depending on the testability of a given system function. The objective is always to perform the test at realistic conditions representing the actual conditions at the time of required functional operation. If important system functions are not directly testable, e.g. integrity at higher levels of pressure and temperature, functional performance is verified indirectly. The specified required tests are reviewed regularly considering operating experience and new findings from safety research, and are adapted if necessary. Intended modifications of the testing manual are submitted to the supervisory authority for approval. Table 14-2 lists the nature and average number of the in-service inspections per year with refuelling outage required according to the testing schedule, which is typical of a nuclear power plant with a pressurised water reactor.

Table 14-2 Annual average number of in-service inspections, typical for a PWR (construction line 3) with one refuelling outage per year

Items	During operation	During outage	Total
Visual and functional tests	3698	527	4225
Radiation protection	400	3	403
Lifting equipment	134	12	146
Non-destructive tests	24	40	62
Civil engineering	28	5	33
Plant security	307	1	308
Total	4591	588	5179

Apart from the mandatory in-service inspections of systems and components important to safety, the licensee performs additional inspections under his own responsibility, which serve to ensure plant availability.

In addition, the plant operator performs the tests and inspections required by law in accordance with the conventional rules and regulations (e.g. according to the Operational Safety Ordinance).

To ensure that indications, deficiencies and failures requiring remedial measures safely pass through the process of technical clarification up to the performance of the necessary measures after their detection, a corresponding operational management system, generally computer-based, is implemented. In this way it is ensured that deviations from specified plant conditions lead to the necessary repairs. Further details on this issue are included in Article 19 (iii).

Ageing management

The measures for maintaining quality over a long period of time (ageing management) are an integral part of the quality requirements specified in the German nuclear rules and regulations, particularly in the KTA safety standards. These deal with ageing phenomena under the term “operational influences”.

Comprehensive measures are employed in German nuclear power plants to counter the inadmissible effects from ageing. These measures are, in particular,

- the consideration of current knowledge on ageing during design, construction, manufacturing and inspection of technical systems,
- the monitoring of systems and operating conditions with respect to detecting any deterioration important to safety,
- the regular replacement of system component parts known to be susceptible to failure by preventive maintenance (→ Article 19 (iii)),
- an upgrading or replacement of technical systems in case weaknesses important to safety are found (→ Article 18 (ii)),
- the optimisation of technical systems and of operating conditions,
- continuous evaluation of operating experience, including the implementation of findings from experience feedback (→ Article 19 (vii)),
- acquisition and maintenance of qualification at a sufficiently high level (→ Article 11 (2)).

This practice is supplemented by appropriate research and development.

The evaluation of the results of the in-service inspections with special attention to systematic deficiencies ensures detection of failure causes due to ageing at an early stage. There are specific regulatory requirements regarding ageing of certain plant components (e.g. fatigue analyses for components of the pressure boundary according to safety standard [KTA 3201.2], or type tests of instrumentation and control equipment according to safety standard [KTA 3503] or type tests of electrical drives according to safety standard [KTA 3504]). Due to the high frequency of inspections of the safety equipment in German nuclear power plants, ageing phenomena are usually detected at an early stage and countermeasures are taken. This is why failures due to ageing caused by systematic phenomena have so far been observed only rarely.

The monitoring of safety-related components for service-induced changes is, in a comprehensive manner, included in the approved and by regulatory supervision accompanied programme of the in-service inspections. In addition, the plant operators developed an ageing management concept that also considers the other availability-relevant components in a monitoring programme under their own responsibility. This concept is currently being implemented and further development in the plants with an increasing level of detail. In this connection, generic aspects are pursued within the framework of projects of plant operators beyond a plant-specific level.

The installation of the ageing management system in the plants is at an advanced stage. The implementation is intensively accompanied by the supervisory authorities.

A special case is the neutron embrittlement of the pressure-retaining boundary of the reactor pressure vessel. To be able to assess the change of the material properties due to neutron irradiation, suspended surveillance samples of the original material of the reactor pressure vessel (accelerated irradiation capsules) have to be tested at several intervals. The test results deliver fracture mechanical parameters on which an assessment of the integrity of the reactor pressure vessel can then be based. Corresponding results are available for all plants and show sufficient fracture toughness until the end of the scheduled operating lives.

The evaluation of operating experience beyond a plant-specific level shows that the above-mentioned measures have largely been effective so far. The number of events with damages due to ageing phenomena at German plants is low. In this respect, all plants were affected by age-induced events, but to a different degree. Until now, a significant increase in age-induced events with increasing operating time has not been observed.

In July 2004, the RSK submitted a recommendation on the "Management of ageing processes at nuclear power plants". It proposes, among others, to prepare plant-specific basic reports on ageing management which are to be updated at regular intervals. The authorities observe the implementation of the ageing management systems in the Technical Committee for Nuclear Safety of the *Länder* Committee for Nuclear Energy and its working group on supervision and reactor operation.

In November 2005, the Nuclear Safety Standards Committee (KTA) passed the decision to initiate project work on a new KTA safety standard on the topic of ageing management. The work was started in May 2006. Since 11/2009, safety standard [KTA 1403] "Ageing Management in Nuclear Power Plants" has been available as a draft.

Measures for internal reviews of the plant operators

<u>WANO peer reviews</u>

The operators of the German nuclear power plants perform national peer reviews in the style of the WANO peer reviews. The aim of this initiative is to obtain representative information on the quality of the administrative/operative plant management, analogous to the WANO peer reviews, and to perform optimisations, if required. Thirteen representative processes (among others maintenance, evaluation of operating experiences, technical qualification, engineering/contracting) were selected for these reviews which are periodically performed by experts of other German plants for about three review days each. In general, a national peer review is performed at every German nuclear power plant once a year.

In addition, safety-relevant processes are reviewed within the framework of WANO peer reviews by international experts.

In Germany, WANO peer reviews were conducted successively for all plants in operation. From 1997 to 2009, the plants Grohnde (1997), Grafenrheinfeld (1999), Gundremmingen (2000), Neckarwestheim (2001), Brunsbüttel (2001 and 2005), Isar (2003), Emsland (2004), Brokdorf (2005), Biblis (2005), Unterweser (2005), Krümmel (2006 and 2009), Gundremmingen (2007), Grafenrheinfeld (2007), Grohnde (2007), Isar (2009), Philippsburg (2009) were subjected to an audit.

For a second cycle for the performance of WANO peer reviews, the following proposal on scheduling was made: Emsland (2010), Brokdorf (2010), Brunsbüttel (2010), Neckarwestheim (2011), Biblis (2011), Unterweser (2011) and Krümmel (2011).

<u>National peer reviews</u>

On average, a national peer review is performed at every German nuclear power plant once a year (→ Article 9). From 2008 to 2010, there was a total of 35 peer reviews, involving all plants in operation.

Altogether, a large number of recommendations was developed in the reviews which led to improvements in the plants. However, the benefit for the German nuclear power plants is not only generated by the recommendations of the teams but also by the gain in experience of the peers from German nuclear power plants who frequently participate in international WANO peer reviews.

OSART missions

Upon invitation, the IAEA has so far conducted five OSART missions at German nuclear power plants. The dates of the missions are mainly concentrated on the first period at the end of the 1990s and at the beginning of the 1980s: Biblis A (DWR) 1986, Krümmel (SWR) 1987, Philippsburg 2 (DWR) 1987, 2004 with follow-up 2006 and Grafenrheinfeld (DWR) 1991 (with follow-up mission 1993).

The last OSART mission in Germany was performed in 2007 in Neckarwestheim. The follow-up mission in May 2009 showed that the majority of the suggestions resulting from the mission have already been fulfilled and satisfactory progress has been made regarding the remaining suggestions. So, improvement measures were performed with regard to

– competencies and responsibilities relating to emergency planning,
– communication, team organisation and processes,
– structuring and accessibility of plant documentation under consideration of the hierarchy level and safety relevance of the individual documents, and
– proceeding in case of plant modifications limited in time.

Dates for further OSART missions in a German nuclear power plant have not been scheduled yet.

Reviews within the framework of state supervision

The nuclear licensing and supervisory authority monitors and, if necessary, enforces the fulfilment of the obligations of the plant operator relating to the licence.

In addition to the inspections performed by the plant operator, safety verifications are performed within the framework of regulatory supervision. The supervisory authorities verify by means of different methods whether the plant operators meet their obligations. The choice of the methods depends, among other things, on the plant state, such as construction, operation, outage or implementation of modification.

Accompanying inspections during construction, commissioning and modification

During the construction and commissioning phase, the authorised experts called in by the supervisory authority will perform accompanying inspections in order to supervise the compliance with the licence provisions and those of the supervisory procedure. These accompanying inspections are performed independent of those by the manufacturer. They are required to verify the values, dimensions, or functions specified in the submitted documents. This includes e.g. the verification of materials compositions, checking of the assembling of components, and the performance of functional tests at the manufacturing plant. Similar inspections are also carried out at the construction site. During commissioning, the provisions of the plant's safety specification as well as the compliance with the boundary conditions for the accident analysis are checked (→ Article 19 (i)).

<u>Inspections during operation</u>

For tests and controls at the nuclear power plant, the supervisory authority of the respective *Land* performs on-site inspections at regular intervals, in part also with the consultation of authorised experts. Such inspections may be directed to the clarification of specific issues or be performed with the objective of a general plant walkdown.

Routine inspections are performed, for example, on

- the fulfilment of the protection provisions of the Radiation Protection Ordinance (marking of radioactive substances, delimitation and marking of exclusion areas and controlled areas, performance of contamination and local dose rate measurements, equipment of the employees with dosimeters),
- the fulfilment of the provisions on physical protection,
- the presence of the operating and monitoring personnel,
- the fire protection measures and the condition of the escape and emergency routes under safety-related aspects, and
- the compliance with the provisions on tag-out and work order approval procedures.

Moreover, on-site inspections serve to inform about the status and progress of maintenance processes and modification measures and to review the operating manual at the control room, the shift and security logs and other records kept by the plant operator. Moreover, the records on personal dosimetry, on the radioactive emissions and other records to be made by the plant operator are controlled in the plant at irregular intervals.

The on-site inspections by the supervisory authority are supplemented by plant walkdowns and controls of the operational management performed by an expert consulted. These on-site inspections by the authorised experts are carried out on the basis of annual plans that are agreed upon between the expert and the supervisory authority. The in-service inspections on safety-relevant components carried out by the plant operator are accompanied by the authorised experts of the supervisory authorities at specified intervals. In addition to such inspections not bound to a specific occasion, there are also on-site inspections due to reportable events or other indications during which the supervisory authority and their experts build their own picture.

The plant operators are obliged, e.g. pursuant to licensing provisions, to submit reports on different subject areas. These include, e.g., subject matters related to operation, safety and radiation protection, including environmental monitoring, and on the radioactive material inventory and use. Such reports are evaluated by the supervisory authority, subordinate authorities or by experts consulted. Findings are handled by further investigations.

The current operating conditions of the nuclear power plants are directly monitored by the supervisory authority of the respective *Land* or a subordinate authority by means of the remote monitoring system for nuclear reactors (KFÜ) (→ Article 15). With this transmission system, the authority staff can monitor essential operating parameters and emission dates of the plant online. The values transmitted are updated at short intervals and stored so that they will also be available, if required, for future investigations. If specified limits are exceeded, the supervisory authority is alerted automatically.

Article 14: Progress and changes since 2007

Since 2007, additional safety reviews required by law have been performed in the nuclear power plants Neckarwestheim-1, Gundremmingen-B, Gundremmingen-C, Grafenrheinfeld, Krümmel, Philippsburg-2, Isar-2, Emsland and Neckarwestheim-2. For the plants Grohnde and Biblis B completion is expected by the end of 2010.

In November 2005, the Nuclear Safety Standards Committee (KTA) passed the decision to initiate project work on a new KTA safety standard on the topic of ageing management. The work was started in May 2006. Since 11/2009, safety standard [KTA 1403] “Ageing Management in Nuclear Power Plants” has been available as a draft.

Since 2007, the nuclear power plants Gundremmingen (2007), Grafenrheinfeld (2007), Grohnde (2007), Isar (2009) and Philippsburg (2009) have been subjected to an audit within the framework of WANO peer reviews.

Article 14: Future activities

The update of the technical documents on PSA methods (methods for the probabilistic safety analysis for nuclear power plants and data for the probabilistic safety analysis for nuclear power plants) [4-7] is currently under discussion with regard to the issues of low power and shutdown operation, personnel actions, earthquake PSA and Level 2 PSA.

The scheduling for further WANO peer reviews is as follows: Emsland (2010), Brokdorf (2010), Brunsbüttel (2010), Neckarwestheim (2011), Biblis (2011), Unterweser (2011) and Krümmel (2011). Dates beyond 2011 have not been scheduled so far.

15 Radiation protection

ARTICLE 15 RADIATION PROTECTION

Each Contracting Party shall take the appropriate steps to ensure that in all operational states the radiation exposure to the workers and the public caused by a nuclear installation shall be kept as low as reasonably achievable and that no individual shall be exposed to radiation doses which exceed prescribed national dose limits.

Overview concerning the rules and regulations

Basic regulatory requirements

The Radiation Protection Ordinance [1A-8] is the legal basis for the handling of radioactive material. Over the years, it has repeatedly been amended and adapted to the respective EURATOM Basic Safety Standards [1F-18] which prescribe the framework for radiation protection in the European Union. The ordinance includes provisions by which man and the environment are protected from damage due to natural and man-induced ionising radiation. In the Radiation Protection Ordinance, requirements and limits are laid down to be observed when using radioactive material. This also covers the handling of nuclear fuel, as well as construction, operation and decommissioning of nuclear installations defined according to Section 7 of the Atomic Energy Act [1A-3]. The Radiation Protection Ordinance specifies requirements for organisational/administrative and physical/technical protection measures and for medical surveillance. Moreover, it also specifies licensing obligations for the handling of radioactive material, for their import, export and for their transport.

Relevant for performing practices in terms of the Radiation Protection Ordinance are, in addition to the principles of justification and limitation of radiation exposure included therein, the following radiation protection principles specified in Section 6 of the Radiation Protection Ordinance:

- Anyone who plans or performs a practice shall avoid any unnecessary radiation exposure or contamination of man and environment.
- Anyone who plans or performs a practice shall minimize any unnecessary radiation exposure or contamination of man and environment, even if below the respective limit, by taking into consideration the state of the art and by taking into account all circumstances of individual cases.

Together with the principle of proportionality - a constitutional principle to be accounted for in all cases - these principles lead to an obligation to optimise radiation protection in terms of the ALARA principle.

The main dose limits for the annual effective dose, organ doses and the lifetime dose specified in the Radiation Protection Ordinance are addressed in the following and listed in Table 15-1.

Table 15-1 Dose limits according to the Radiation Protection Ordinance

Sec-tion	Scope of applicability	Time period	Limit [mSv]
	Design and operation of nuclear installations		
46	**Environment of nuclear installations**		
	Effective dose: external radiation exposure from the installation and contributions from its discharges	Calendar year	1.0
	Organ dose: eye lens	Calendar year	15
	Organ dose: skin	Calendar year	50
47	**Limits for the discharges with exhaust air or waste water during normal operation**		
	Effective dose	Calendar year	0.3
	Organ dose: bone surface, skin	Calendar year	1.8
	Organ dose: gonads, uterus, red bone marrow	Calendar year	0.3
	Organ dose: great gut, lung, stomach, bladder, breast, liver, gullet, thyroid, other organs or tissues unless specified above	Calendar year	0.9
49	**Design basis accident limits**		
	Effective dose	Event	50
	Organ dose: thyroid and eye lens	Event	150
	Organ dose: skin, hands, forearms, feet, ankles	Event	500
	Organ dose: gonads, uterus, red bone marrow	Event	50
	Organ dose: bone surface	Event	300
	Organ dose: great gut, lung, stomach, bladder, breast, liver, gullet, other organs or tissues unless specified above	Event	150
	Dose limits for occupationally exposed persons		
55	Occupationally exposed persons of **Category A**		
	Effective dose	Calendar year	20
	Organ dose: eye lens	Calendar year	150
	Organ dose: skin, hands, forearms, feet, ankles	Calendar year	500
	Organ dose: gonads, uterus, red bone marrow	Calendar year	50
	Organ dose: thyroid, bone surface	Calendar year	300
	Organ dose: great gut, lung, stomach, bladder, breast, liver, gullet, other organs or tissues unless specified above	Calendar year	150
	Occupationally exposed persons of **Category B**		
	Effective dose	Calendar year	6
	Organ dose: eye lens	Calendar year	45
	Organ dose: skin, hands, forearms, feet, ankles	Calendar year	150
	Effective dose for **persons under age 18**	Calendar year	1
	Trainees and students age 16 - 18 with agreement by the authority	Calendar year	6
	Organ dose: uterus of **women of childbearing age**	Month	2
	Foetus	Time of pregnancy	1
56	Effective dose	Entire life	400
58	**Radiation exposure** permitted in exceptional circumstances (only volunteers of Category A, after approval by the authority)		
	Effective dose	Professional life	100
	Organ dose: eye lens	Professional life	300
	Organ dose: skin, hands, forearms, feet, ankles	Professional life	1000
59	Regarding measures for **removal of pending danger to persons** it is to be achieved that an effective dose of more than 100 mSv only occurs once per calendar year and an effective dose of more than 250 mSv only once in a lifetime (only volunteers over age 18).		

Requirements concerning the protection of the staff

The radiation exposure of the personnel is limited by the Radiation Protection Ordinance (→ Table 15-1). The prescribed limit for the body dose of occupationally exposed persons is a maximum effective dose of 20 mSv per calendar year. Other limits are stipulated for organs and tissues. Stricter limits apply to persons under 18 years and women of childbearing potential. A foetus shall not receive more than 1 mSv due to the occupational exposure of the mother. The sum of effective doses of occupationally exposed persons added in all calendar years shall not exceed the life time dose of 400 mSv to ensure that radiation exposure of the personnel during the professional life is limited to an acceptable degree.

Exposures to radiation exceeding these limits per calendar year may be allowed up to 100 mSv in order to perform necessary work under exceptional circumstances. Regarding measures to avert danger to persons it shall be achieved that an effective dose effective dose of more than 100 mSv only occurs once per calendar year and an effective dose of more than 250 mSv only once in a lifetime.

The body doses are determined for persons spending any time in the radiologically controlled area. This is usually done by measuring the personal dose by means of electronic dosimeters of the plant operator and by official passive dosimeters. In addition, the dose due to incorporation is usually determined by monitoring of the airborne activity concentration or by measuring whole-body or partial body doses. Further details are specified in the guidelines for the determination of body doses from external and internal radiation exposure [3-42.1] and [3-42.2]. Beside the operational dosimetry based on the operational electronic dosimeters of the plant operator, an independent official dosimetry of the personnel is performed. This official dosimetry is based on passive dosimeters issued and evaluated by measuring institutions, which are designated by the competent authority. The usually monthly measured values are transmitted by the measuring institutions to the radiation protection supervisor or radiation protection officer of the nuclear installation and to the central Radiation Protection Register.

Guideline [3-42.2] was last revised in 2007. In doing so, the requirements regarding the determination of internal radiation exposure were adapted to the provisions of the Radiation Protection Ordinance. Here, in particular, dose coefficients and retention functions were recalculated and made available in tabular form. Furthermore, the requirements mentioned in several guidelines concerning the determination of the internal radiation exposure were revised and bundled in guideline [3-42.2] so that these guidelines could be repealed.

For occupationally exposed persons, distinction is made between Categories A and B. Persons with a potential occupational radiation exposure of more than 6 mSv per year are classified as Category A. For these persons, occupational medical care carried out by authorised physicians is provided on an annual basis. For persons of Category B, the effective annual dose may not exceed 6 mSv. Their medical examination is only performed as specifically stipulated by the authority. Moreover, a radiation passport is to be maintained for persons working in foreign radiologically controlled areas. The corresponding regulations [2-2] ensure that exposures from activities – also outside of nuclear power plants (e.g. during radiography in the conventional industry sector) or in connection with activities in an environment with naturally occurring radionuclides – are also taken into consideration for this group of people; thus it is ensured that the dose limits specified in the Radiation Protection Ordinance are complied with on the basis of the overall exposure from all activities.

The protection of the personnel working in nuclear power plants was considered during the design of the nuclear power plants by implementing the provisions of the Radiation Protection Ordinance and subordinate legislation, such as guideline [3-43] and safety standard [KTA 1301.1]. The design-related aspects are also taken into consideration with regard to significant plant modifications. Already at an early stage, organisational and technical measures for reduction of the radiation exposure of persons working at the plant were incorporated in safety standard [KTA 1301.2] and in the guideline on radiation protection measures during operation of a nuclear installation [3-43.1] (→ Article 15.2).

Requirements regarding the protection of the public

Radiation exposure of the public during specified normal operation

The dose limits and requirements applying to the radiation exposure of the public during operating conditions of nuclear installations are laid down in Sections 46 and 47 of the Radiation Protection Ordinance (→ Table 15-1).

A limit of 1 mSv per calendar year is specified for the effective dose by external radiation and the radiation exposure from discharges. In addition, there are limits for specified organs and tissues. For determining the exposure from external radiation, permanent stay is to be assumed in the plant design unless there are justifications for times of stay deviating from it.

The contributions of discharges to exposure are limited by Section 47 of the Radiation Protection Ordinance. For planning, construction and operation of nuclear installations, a maximum effective dose of 0.3 mSv per calendar year is applicable to radiation exposures of members of the public resulting from discharges of radioactive material with exhaust air or with waste water. Further limits apply to specified organs and tissues.

Any radioactive discharge is recorded in the nuclide-specific balance sheets. These allow calculating the radiation exposure within the vicinity of the nuclear installation. The analytical models and parameters used in these calculations are specified in the Radiation Protection Ordinance and in a general administrative provision [2-1]. Accordingly, the radiation exposure shall be calculated for a reference person and all exposure pathways at the most unfavourable receiving points such that the radiation exposure to be expected will not be underestimated.

Radiation exposure of the public in case of design basis accidents

Central issues evaluated during the licensing procedure of a nuclear power plant are the planned structural and technical measures for the control of design basis accidents (→ Article 18 (i)). In accordance with Section 49 of the Radiation Protection Ordinance it has to be shown that, under consideration of the requirements of Section 6 of the Radiation Protection Ordinance (prevention of unnecessary radiation exposure, ALARA principle), the effective dose in the vicinity of the nuclear installation will not exceed the planning value of 50 mSv in a design basis accident (integrated over all exposure paths as 50-year and 70-year dose commitment). Further planning values apply to specified organs and tissues. Regulatory guideline "Incident calculation bases" [3-33] specifies the analytical models and assumptions to be applied for these verifications.

Radiation exposure of the public in case of beyond design basis accidents

Due to the design of the plants, these accidents are very improbable. Specification of dose limits and reference values as set targets for the protection of the public is not practicable. Instead, among others confirmed by the results of risk studies and probabilistic safety analyses, organisational and technical measures were taken within the framework of plant-internal accident management for the protection of the public in order to control beyond design basis plant states or at least to mitigate their consequences on-site and off-site the plant (→ Article 18). This is to prevent radiological situations which require drastic actions, such as evacuations or long-term resettlements. Notwithstanding this on-site emergency response, additional measures can be taken, if required, for the protection of the public within the framework of off-site emergency planning (→ Article 16) if there are significant releases or the risk of such releases.

Emission and immission monitoring

The discharge of radioactive material is permitted with the operating licences. The licensing authorities stipulate maximum permissible activity amounts and concentrations for discharges that are calculated such that, under consideration of the site-specific dispersion conditions and exposure pathways, the potential radiation exposure for members of the public resulting from discharges to the extent of the permissible activity amounts and concentrations does not exceed the limits of Section 47 of the Radiation Protection Ordinance (→ Table 15-1). Together with the contribution by external radiation, the limits of Section 46 of the Radiation Protection Ordinance shall not be exceeded.

Section 6 of the Radiation Protection Ordinance stipulates that discharges of radioactive material shall be kept as low as achievable by taking into account all circumstances of the individual case and taking due account of the state of the art, even where the values are below the limits of the operating license. Thus, high demands are placed on the quality of the fuel elements, the composition of the materials and the purity of the water used in the primary system for activity limitation and for preventing the contamination of components and systems. In addition, the plants are equipped with devices for the retention of radioactive material.

Emission monitoring

According to Section 47 of the Radiation Protection Ordinance [1A-8], any uncontrolled release of radioactive material into the environment must be avoided. The basis for monitoring and balancing of the emissions is established in Section 48 of the Radiation Protection Ordinance. The programmes for the emission monitoring during specified normal operation and in case of design basis accidents correspond to the Guideline on Emission and Immission monitoring [3-23] and the safety standards [KTA 1503.1], [KTA 1503.2], [KTA 1503.3] and [KTA 1504] which were last revised in 2007. The operators of nuclear installations carry out these monitoring measures and submit the results to the nuclear supervisory authorities.

The sampling and measurement methods are oriented toward the two tasks of monitoring by continuous monitoring on the one hand, and sampling for balancing the discharge of radioactive material via the paths exhaust air and waste water according to type and amount on the other hand.

Continuous measurement is performed to monitor the discharge of the nuclides or nuclide groups with exhaust air for radioactive noble gases, radioactive aerosols and for iodine-131 and with waste water for gamma-emitting nuclides. For the determination of releases that may occur as a result of design basis accidents, instruments with extended measurement ranges are applied. In addition to the measuring instruments of the plant operators, there are also instruments of the supervisory authorities whose data are transmitted online via the KFÜ data network.

The balancing of the discharge with exhaust air comprises the following nuclides and nuclide groups: radioactive noble gases, radioactive aerosols, radioactive gaseous iodine, tritium, radioactive strontium, alpha emitters and carbon-14. For the waste water pathway, gamma-emitting nuclides, radioactive strontium, alpha emitters, tritium, iron-55 and nickel-63 are balanced. Reports on the balanced discharges are generally submitted to the supervisory authority every quarter as well as yearly ([KTA 1503.1], [KTA 1504]).

The external radiation from the plant is monitored by dose rate measurements at the fence.

According to the guideline on the control of the radiation measurement programme performed under the responsibility of the plant operator [3-44], the Federal Office for Radiation Protection performs a programme to control the operator's measurement programme. For that, for controlling the monitoring of emissions with exhaust air, control measurements are performed on aerosol filter samples, iodine filter samples, tritium samples and carbon-14 samples and comparative measurements at the plant for determining the emission of radioactive noble gases. For controlling the monitoring of emissions with water, samples are analysed for gamma-emitting nuclides, tritium, strontium and alpha emitters. The results of the control measurements are submitted to the supervisory authorities. According to the above-mentioned guideline [3-44], the plant operators are also obliged to participate in round-robin tests. These round-robin tests supplement the comprehensive quality control of the nuclear power plant operators.

In order to be able to evaluate the consequences of the discharge of radioactive material, the plant operator records the site-specific meteorological and hydrological parameters important to the dispersion and deposition of radioactive material. The requirements for meteorological Instrumentation are included in safety standard [KTA 1508]. The major parameters influencing dispersion and deposition in the receiving water are also determined; these are the average water runoffs of the river over the full length of the year and over the six-months summer period.

During its revision in 2007, safety standard [KTA 1504] was adapted to the current state of the art in science and technology. In particular the requirements concerning the monitoring and balancing of radioactively contaminated waste water and the measurements for the decision on the discharge of the radioactively contaminated waste water from the transfer cask to the waste water pathway were revised and specified. Furthermore, the existing requirements were, where required, adapted to the regulations of the Radiation Protection Ordinance [1A-8] and the modified Water Resources Act of 19 August 2002.

Immission monitoring

According to Section 48 of the Radiation Protection Ordinance [1A-8], the plant operators perform a programme on immission monitoring in the vicinity of the plant as ordered by the authorities. In addition, measurements are performed by independent measuring institutions on behalf of the authority.

Immission monitoring supplements emission monitoring. It allows additional controls of the discharges and controls to verify compliance with the dose limits in the vicinity of the plant. The Guideline on Emission and Immission Monitoring [3-23] specifies programmes for immission monitoring prior to commissioning, during specified normal operation, during incidents or accidents and in the phase of decommissioning and safe enclosure. These programmes are to be implemented by the plant operator and the independent measuring institution. Site-specific circumstances and conditions are considered additionally.

Measurements prior to commissioning comprise the still uninfluenced environmental radioactivity and radiation exposure. Monitoring measures during operation serve, among other things, to monitor long-term changes that may occur due to the discharge of radioactive material. Incident and accident measurement programmes, set up in advance, are the basis for taking samples and for the measurements and evaluations in the event of a design basis accident or beyond design basis accident. Immission monitoring considers exposure pathways that may lead to radiation exposure of the public. The sampling and measurement methods ensure that relevant dose contributions by external exposure, inhalation and ingestion can be identified during specified normal operation and can be determined in the case of design basis or beyond design basis accidents.

The results of immission monitoring are submitted to the authority. Data on immissions are centrally recorded, evaluated and published at the BfS.

Remote monitoring of nuclear power plants (KFÜ)

In addition to the radiation measurement programme performed under the responsibility of the licensee, the licensing and supervisory authorities of the *Länder* being competent according to nuclear law have their own systems for continuous acquisition of measurement data regarding emission and immission behaviour of the plant (*Kernkraftwerk-Fernüberwachungssystem* (KFÜ)). Together with the fast transfer of operational data, this continuous monitoring is an effective instrument of regulatory supervision according to Section 19 of the Atomic Energy Act.

The basic requirements for the remote monitoring system are laid down in the basic recommendations for the remote monitoring system for nuclear power plants [3-54]. The actual details are specified under the responsibility of the respective supervising *Land*.

Main function of the KFÜ is the continuous emission monitoring which is partly designed redundant to the radiation measurement programme performed under the responsibility of the plant operator and the immission monitoring in the vicinity of the plants. Further, meteorological data are continuously transmitted to the supervisory authority. Different operating parameters give indications to the operating status of the plants.

The use of the data acquired within the KFÜ mainly cover the regulatory supervision of the operational processes and automatically initiated alerting of the supervisory authority in the case of excess of permitted values. Further processing of these data in connection with meteorological factors in suitable computer codes allows assessing and predicting of the radiological exposure in the vicinity of the plants, in particular after release of radioactive material in case of incidents or accidents. Thus, the results also serve the purposes of emergency response.

Monitoring of environmental radioactivity / Integrated measurement and information system

In addition to the site-specific monitoring of the vicinities of the nuclear power plants according to the Guideline on Emission and Immission Monitoring [3-23], the general radioactivity in the environment is recorded by extensive measurements in the entire territory of the Federal Republic of Germany by means of the Integrated Measurement and Information System for the Monitoring of Environmental Radiation (IMIS) in accordance with the Precautionary Radiation Protection Act [1A-5]. This system is operated by the BfS. Monitoring comprises all relevant environmental areas from the atmosphere and the surface waters up to sampling of foodstuffs and drinking water. Core piece is the network which, at present, comprises about 1,800 measurement stations for measuring the local gamma dose rate. All data measured are continuously transmitted to the Central Federal Agency (ZdB) for the Monitoring of Environmental Radioactivity operated by the Federal Office for Radiation Protection and from there on to the BMU. This measuring and information system is operated continuously.

Even slight changes in environmental radiation are quickly and reliably detected and evaluated by this system, making it possible to give early warnings to the public, if so required. In the event of increased values in the territory of the Federal Republic of Germany, the BMU will cause IMIS to switch from routine to intense operation which, essentially, means that measurements and samples will be taken more frequently.

The extent and procedures for the corresponding measurements are specified in the general administrative provisions [2-4] for routine and intense operation. The results from these measurements are also used within the framework of international information exchange (→ Article 16 (2)). At present, the measured values of airborne activity and the local gamma dose rate in Germany are displayed in maps placed on the Internet (www.bfs.de) and updated on a weekly basis, with the local gamma dose rate being updated and displayed on a daily basis.

Regulatory requirements for the implementation of the ALARA principle

The protection of the persons working at nuclear power plants was already considered during the design of the nuclear power plant by implementing the provisions of the Radiation Protection Ordinance and subordinate legislation, such as guideline [3-43] and safety standard [KTA 1301.1]. The design-related aspects are also taken into consideration with regard to significant plant modifications. Furthermore, at an early stage, organisational and technical measures to reduce the radiation exposure of persons working at the plant were required as specified in safety standard [KTA 1301.2] and in the guideline on radiation protection measures during operation of a nuclear installation [3-43.1].

In this context, [3-43.1] regulates in detail the planning processes regarding the required radiation protection measures to be taken when carrying out activities in nuclear installations. The planning process depends on the individual and collective doses to be expected as well as on the radiologically relevant boundary conditions. In principle, radiation protection has to be included in the planning at an early stage. Depending on the individual case, the planning is also subject of supervisory inspections. With revision of the guideline in 2004, among other things, the dose reference levels above which a “special radiation protection procedure” must be applied were reduced, i.e. from 50 mSv to 25 mSv for the collective dose and from 10 mSv to 6 mSv for the individual effective dose. The existence of unfavourable radiological conditions may be another criterion. Compared to the “routine radiation protection procedure”, this special radiation protection procedure requires considerably more extensive planning and a more comprehensive inclusion of radiation protection issues.

The requirements of this guideline together with the increased radiation protection awareness among the personnel and the involvement of the supervisory authorities in the inspection of the planning of the radiation protection measures and the implementation thereof form a good basis for the implementation of the ALARA concept with the aim to reduce and optimise radiation exposure at the plants.

Guideline [KTA 1301.2] was last revised in 2008. In doing so, the content was adapted to the specifications of the Radiation Protection Ordinance of 2001 and the modifications that resulted from the revision of guideline [3-43.1] in 2005 were implemented. Experiences gained from the operation of German nuclear power plants were also considered. In particular, the requirements for the radiation protection organisation were specified and thus the importance of the radiation protection organisation in ensuring radiation protection pursuant to guideline [3-43.1] was taken into account.

Results of the implementation of the radiation protection measures by the operator

Exposure of the personnel

Collective and individual doses have clearly decreased until about 2000. Then, the construction lines showed different behaviour to some extent. Figure 15-1 shows the average collective doses per year and plant. The exposures at PWR plants of construction line 4 (Konvoi plants) constantly remain at the same low level. This is due to consequent abandoning the use of any materials containing cobalt in almost all components of the primary system. The PWR plants of construction lines 1 and 3 show a decreasing trend for the collective dose which, for construction line 3, can be attributed to the improvements in radiation protection and the, compared to previous years, small scope of backfitting activities and, for construction line 1, to the decommissioning activities in 2003 and 2005 and the fact that the scope of the associated preceding revisions were smaller. Since May 2005, no pressurised water reactors of construction line 1 have been operated anymore. For plants of construction line 2, the change between years without any revision activities during outage and years with implementation of dose-intensive backfitting activities has led to clear differences from year to year for the period since the year 2000. However, here, too, the long-term reduction of the collective doses becomes observable which, due to the fact that revisions were carried out not at all or to a very small extent only, in 2008 achieved an unusually low value for two of four plants bundled in the construction line (→ Figure 15-2).

With regard to BWR plants, there is a stabilisation of the collective doses for construction lines 69 at a for BWRs low level while at both plants of construction line 72 slightly increased outage doses led to an increase of the collective doses in recent years (→ Figure 15-2).

For 2008, Figure 15-2 shows the contributions to the collective doses of the individual plants in operation according to the different construction lines for both PWRs and BWRs. Additionally, it shows the annual sum of the annual durations of in-service inspections and planned outages and the distribution of the collective dose according to the different modes of operation.

Here, it becomes apparent that for all plants with in-service inspections and outages the highest annual collective dose occurs during planned plant outage or, in case of the plants KKK and KKB, on the year-round outages.

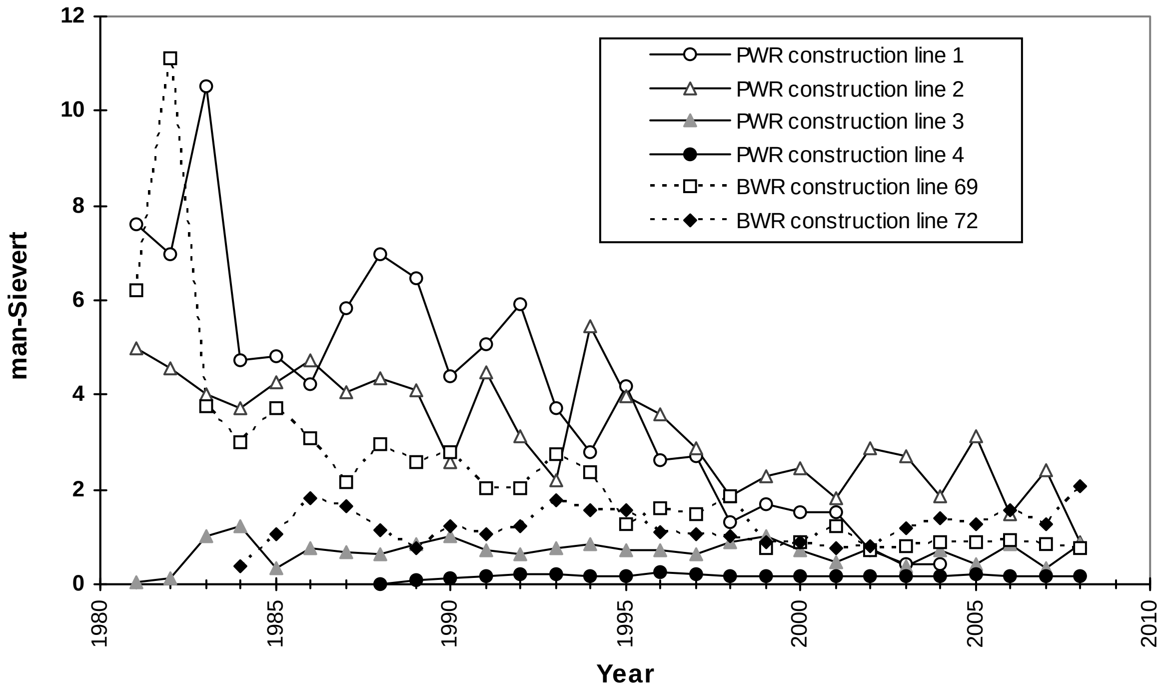
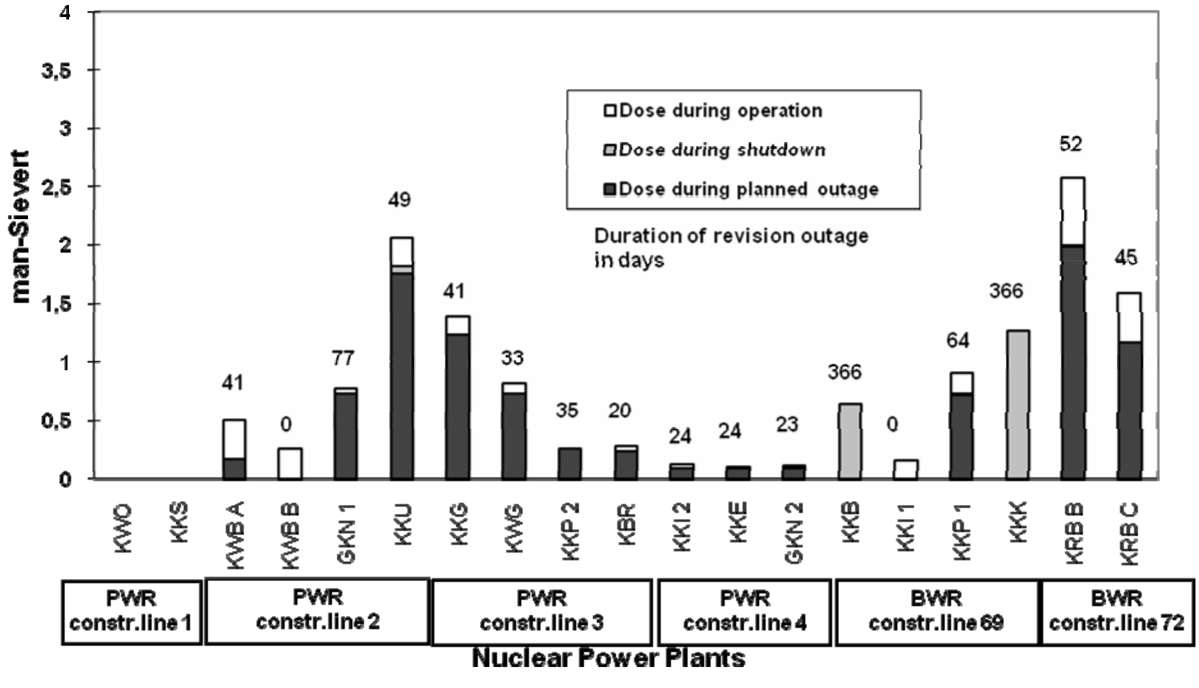


Figure 15-1 Average annual collective dose per year and plant



Dose during operation:	Collective dose during normal power operation
Dose during unplanned outage:	Collective dose during plant shutdowns other than planned outages
Dose during planned outage:	Collective dose during plant outage (scheduled plant revision and/or refuelling outage)

Figure 15-2 Annual collective dose in nuclear power plants in 2008 according to mode of operation, KWO and KKS decommissioned

In the 10-year period of 2000 – 2009, up to 19 nuclear power plants were in operation which corresponds to 179 reactor operating years. From the plants in operation and the up to 19 permanently shutdown plants, a total of 1,252 events was reported which were reportable according to the Nuclear Safety Officer and Reporting Ordinance [1A-17] (→ Article 19 (vi)). 37 of these events led to radiological impacts but did not cause any excess of permissible personal doses.

Discharge of radioactive material during plant operation

Results of the emission monitoring

Except for tritium, the annual discharges reach just a few percentage points of the permitted values. Increased discharges and uncontrolled releases (i.e. releases through pathways not provided for controlled release) occur only very rarely. Within the reporting period (2007 - 2009), no such cases were reported to the authorities according to the radiological reporting criteria [1A-17] (as at 3.8.2009).

The data on discharges of radioactive material with exhaust air and water are published by the Federal Government in its annual report “Environmental Radioactivity and Radiation Exposure“ to the *Bundestag* (the German Federal Parliament), and in a further more detailed annual report with the same name issued by the BMU. Figures 15-3 and 15-4 show the average annual discharges from German nuclear power plants.

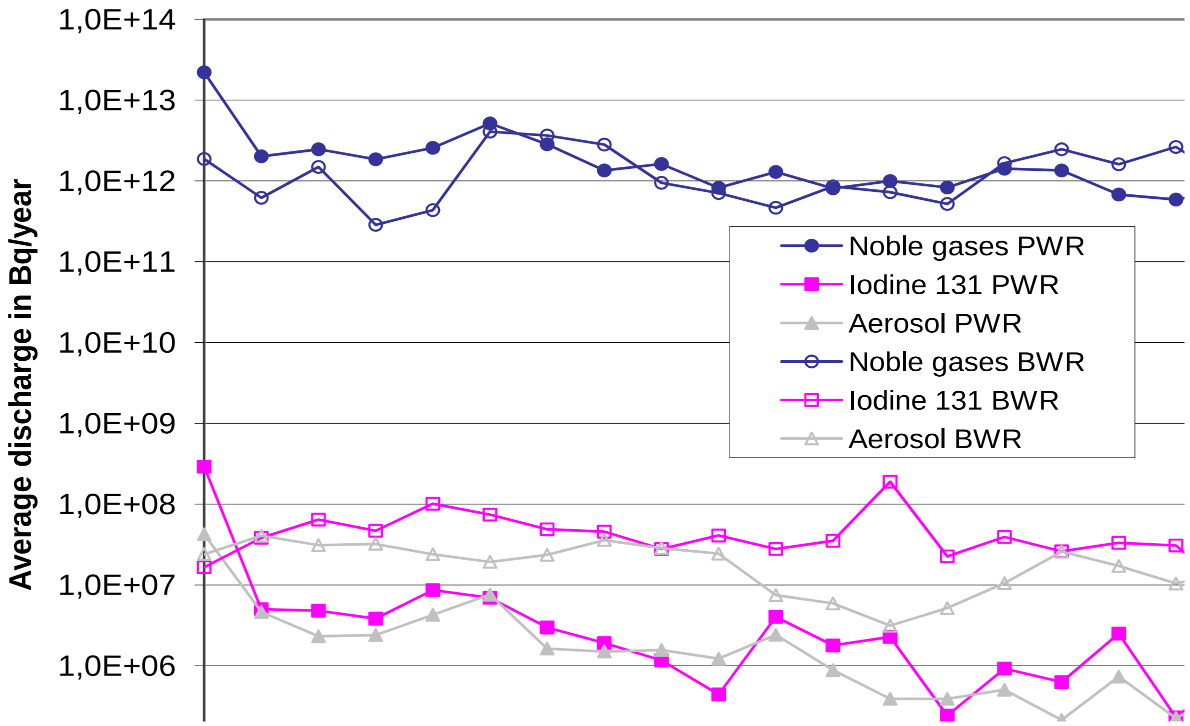


Figure 15-3 **Average annual discharge with exhaust air from PWRs and BWRs in operation**

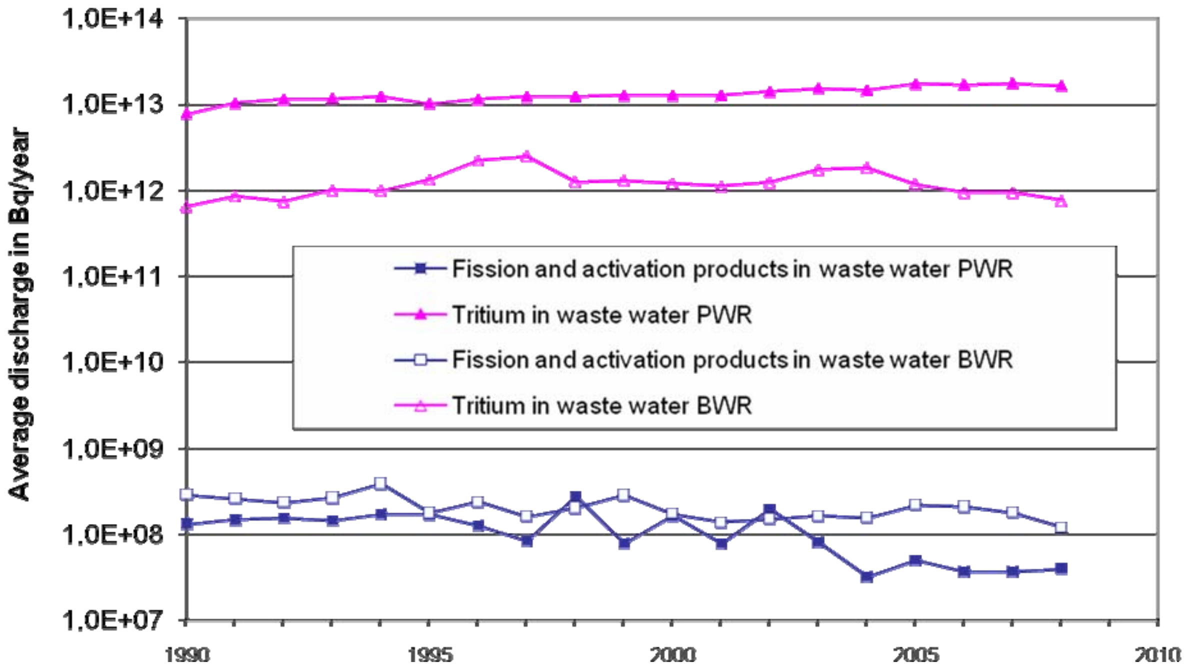


Figure 15-4 Average annual discharge with waste water from PWRs and BWRs in operation

Radiation exposure of the public during specified normal operation

The results show (→ Figure 15-5 to 15-7) that the discharges with exhaust air only lead to doses in the range of a few µSv per year due to the measures of the plants in operation, filtering and only small fuel element defects. The relevant limits of 0.3 mSv for the effective dose and 0.9 mSv for the thyroid dose are only reached to a fractional amount for the highest exposure groups. For waste water, the resulting exposures are even lower with values, in general, of less than 1 µSv. The time histories of the emissions with exhaust air (→ Figure 15-3) and the results of the calculation of the doses of the public (→ Figure 15-7) do not show a direct correlation as due to the very low emissions, the dose is dominated by the discharged carbon-14 isotope for which detection methods and balancing have been changed and improved over the years.

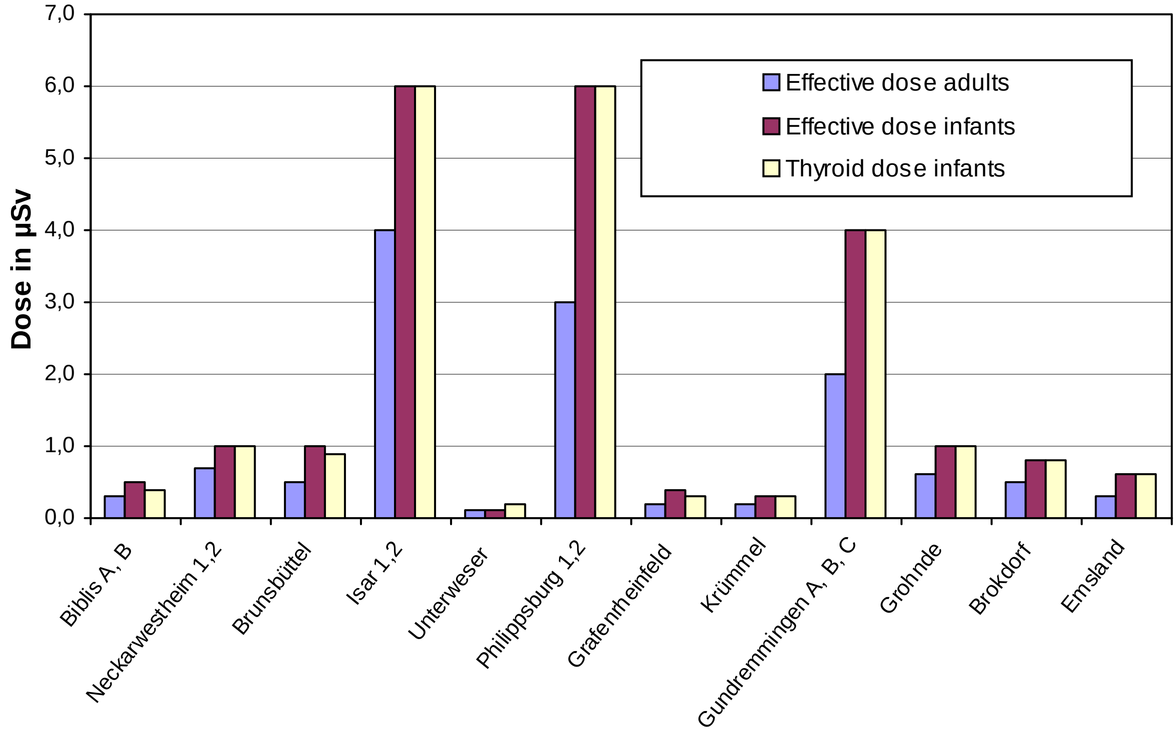


Figure 15-5 **Dose from discharges with exhaust air from plants in operation in 2008**

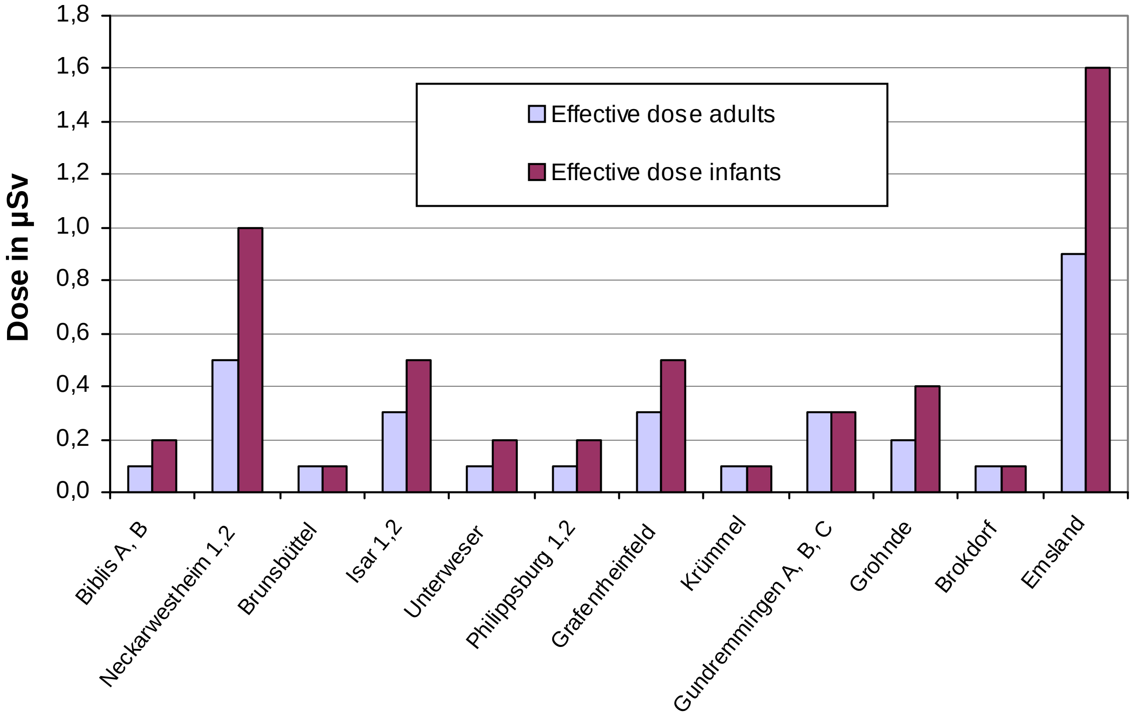


Figure 15-6 **Dose from discharges with waste water from plants in operation in 2008**

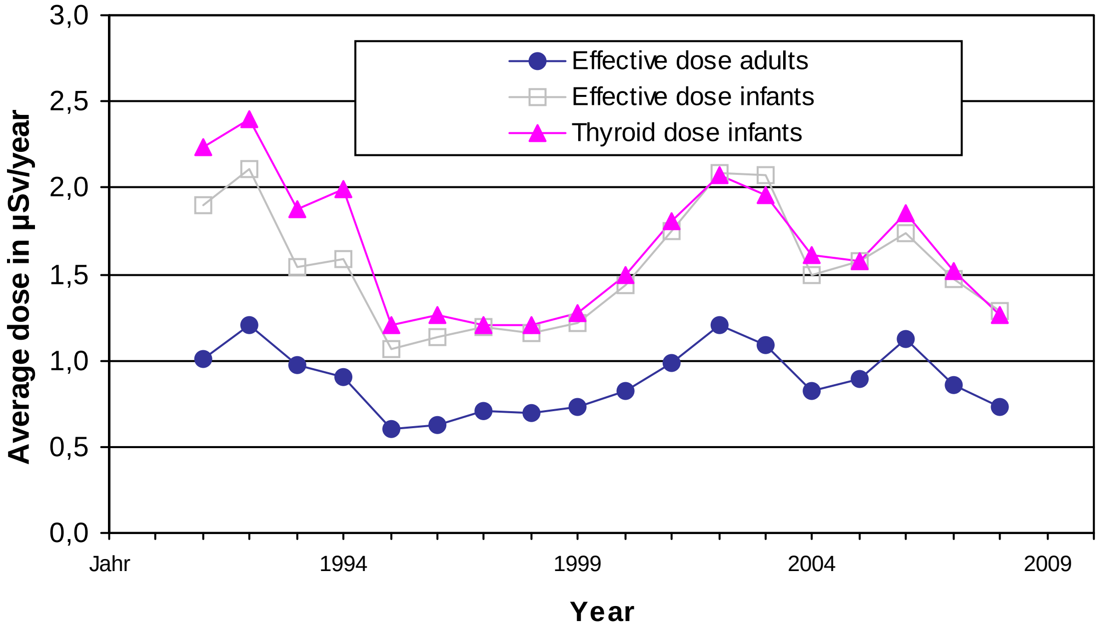


Figure 15-7 **Average dose from discharges with exhaust air from all plants in operation**

<u>Measures for the implementation of the ALARA principle</u>

Guideline [3-43.2] is the central element of the implementation of the ALARA principle in Germany. Due to the scope of the guideline, the radiation protection-oriented requirements concerning the planning of radiation protection measures (routine planning process, special planning process) were taken into account by all nuclear power plants in all their plant-specific planning processes regarding the performance of maintenance, repair, inspection and servicing activities. The application of the planning processes which include, among other things, the evaluation of experiences, is subject of regulatory measures.

Furthermore, the operator carries out generic peer reviews at the national and international level (→ Article 14ii). In Germany, all plants in operation were successively audited with national peer reviews that are based on the WANO peer reviews.

In general, the basic ideas of the ALARA principle are included in the operators' radiation protection measures. They are geared to, among other things:

- Involving the management in radiation protection responsibilities and the support of the implementation
- Decision making strategy to solve the issue of meeting complex radiation protection requirements
- Proportionality of the radiation protection measures
- Evaluation of experience and feedback

One example of activities to implement the ALARA principle during the reporting period is in particular the activities of some plants to reduce the incorporation of airborne tritium activity inside the containment:

In case of airborne activity with tritium, it is theoretically possible for most PWR that the personnel may reach an incorporation dose of more than 0.5 mSv/a and 1 mSv/a, respectively. Therefore, measures were taken to reduce and monitor the tritium incorporation doses. Thus, e.g. the water temperature of the fuel pool was reduced. In addition, a time-dependent monitoring of the incorporation doses for each person was introduced for which the durations of stay inside the containment are electronically recorded.

In the operating procedures of all plants, the requirements concerning the incorporation monitoring were implemented according to the new version of guideline [3.42.2]. Pursuant to this guideline, the requirement threshold above which the determination of the body dose is required, was reduced to 1.0 mSv/a. In case both external and internal radiation sources contribute to the exposure, the authority in charge may reduce the requirement threshold to 0.5 mSv.

To comply with the considerably reduced requirement thresholds of guideline [3.42.2] concerning the personal incorporation monitoring, the operators have developed in the VGB Working Panel "Radiation Protection" a new concept for the limiting and recording of exposure due to incorporation.

Monitoring of environmental radioactivity

The monitoring of the radioactivity in the environment is not only based on the measurements for the emission and immission monitoring of the vicinity of a nuclear power plant, but also on systematic measurements regarding the environmental radioactivity conducted throughout Germany with the independent measuring systems IMIS.

Results of immission monitoring

Immissions resulting from discharges with exhaust air are not detected in the environment even by using the most sensitive analysis methods. The analysis of the ground level air, the precipitation, the soil, the vegetation and the foodstuffs of vegetable and animal origin shows that the content of long-lived radioactive substances, such as caesium-137 and strontium-90 does not differ from the values measured at other locations in Germany. Short-lived nuclides that might originate from discharges from plants with exhaust air also are not detected.

In individual cases, immissions of the water pathway can be detected in surface waters. Occasionally, tritium is measured in samples directly taken at discharge structures. The values are mostly below 100 Bq/l; in individual cases, however, higher maximum values may occur. The nuclide contents of other fission and activation products are generally below the detection limit required for these analyses. The content of long-lived radioactive substances, such as caesium-137 and strontium-90 does not differ from the values measured at other locations in Germany also in this case. Also in sediment samples, the average radionuclide contents are below the required detection limits. In only a few samples directly taken at discharge structures, cobalt-60 can be detected in a small concentration. In 2004, values of 0.5 to 3 Bq/kg dry matter were detected at three sites. No radioactive material was found in fishes, aquatic plants and ground and drinking water that could be attributed to the operation of nuclear power plants. The increase of contents of fission and activation products caused by discharges of radioactive material with water is thus negligibly small.

Results from the measurements with the measuring system IMIS

The Integrated Measurement and Information System for the Monitoring of Environmental Radiation (IMIS) is in operation permanently. During routine operation, the data of airborne activity and the local gamma dose rate in Germany are displayed in maps placed on the Internet (www.bfs.de) and updated on a weekly basis, with the local gamma dose rate being updated and displayed on a daily basis. Figure 15-8 exemplifies data for the local dose rate of 2010.

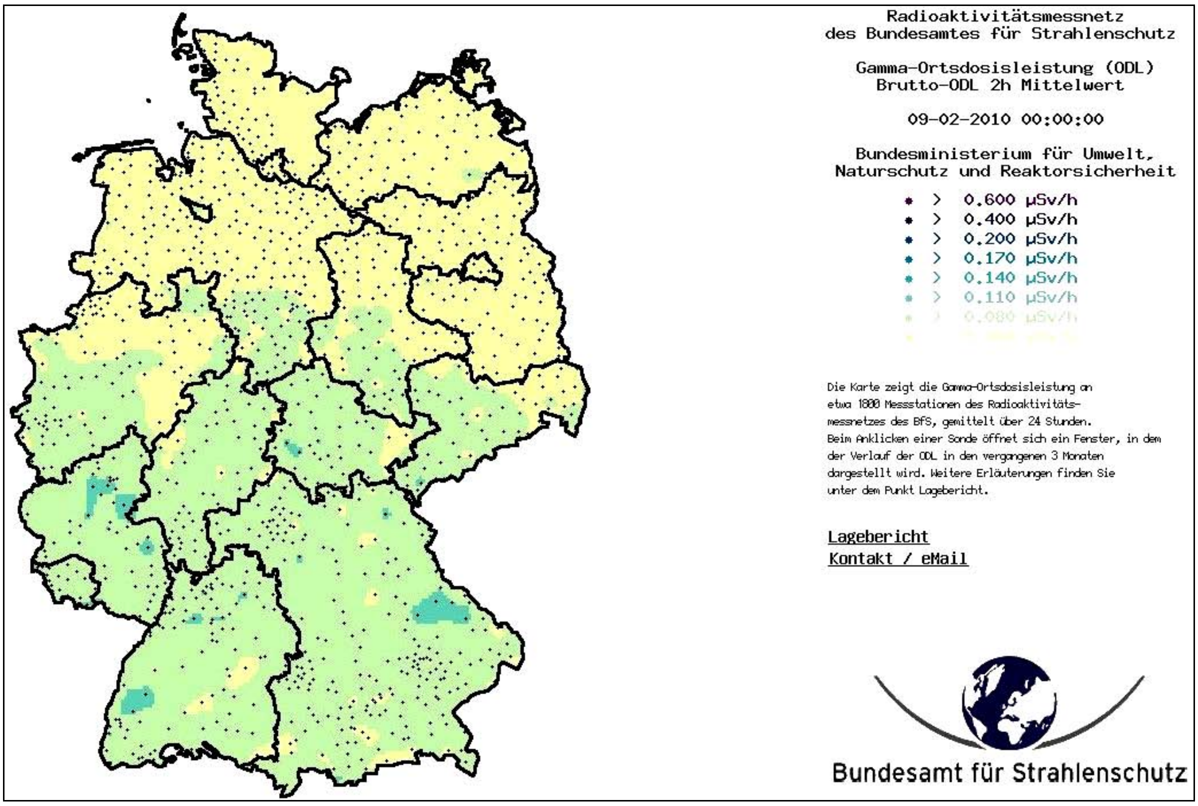


Figure 15-8 Example for the determination of environmental radioactivity by gamma dose rate measurements

Regulatory review and monitoring

The measurements regarding the emission and immission monitoring are carried out by both the operators and the authorities of the Federal Government and the *Länder*.

Emission monitoring is primarily the responsibility of the operator / licensee who causes the emissions (licensee's monitoring). He has to balance the discharges of radioactive materials according to type and activity and in accordance with the state of the art in science and technology and furnish proof of compliance with the maximum permissible (licensed) discharges to the regulatory authority. The maximum permissible discharges derive from the dose limits specified in and to be complied with according to the Radiation Protection Ordinance.

The licensee supplements his proof of compliance with the dose limits according to the Radiation Protection Ordinance by means of an additional measurement programme for the monitoring of the vicinity of the installation or facility.

The correct performance and balancing of the emission monitoring by the licensee (self-monitoring) is verified by an independent measuring institution. So, by order of the regulatory authorities of the *Länder*, the Federal Office for Radiation Protection (BfS) carries out control measurements. If the results of the measurements carried out by the licensee correspond with those carried out by the BfS and do not exceed the measurement-related error tolerance, it can be assumed that the radioactive emissions are recorded and balanced correctly.

The immission measurements carried out by the *Länder* authorities in the vicinity of nuclear installations and facilities supplement the emission monitoring measures of the licensee and BfS. Furthermore, they give information about potential long-term changes of the environmental radioactivity due to operational discharges.

Within the scope of the measuring programmes carried out by the *Länder* authorities in the vicinity of the nuclear installations and facilities, the respective local doses and local dose rates are determined at the selected locations or sites. Also, samples are taken of different environmental media (air, water, soil) and agricultural produce (foodstuff and feedingstuffs) for subsequent laboratory evaluation.

Besides the immediate supervisory radiation protection measures in the individual nuclear power plants, the respective supervisory authorities also monitor the emission and emission of radioactive materials with exhaust air and waste water. To monitor immission, the respective supervisory authority operates measuring systems and facilities (e.g. the Bavarian Air Pollution Monitoring Network for Radioactivity – *bayerisches Immissionsmessnetz für Radioaktivität* (IfR)) to be able to detect increased discharges of radioactive materials early, e.g. in case of an incident.

Within the scope of his responsibility for the emission monitoring, the operator regularly reports to the competent authority on the discharges of radioactive materials. So, in Baden-Wurttemberg, for example, the operator prepares monthly, quarterly and annual reports on the emission monitoring which are verified by the competent authority in respect of completeness, plausibility and consistency. In doing so, data of the immission monitoring carried out by the *Land* and the BfS are also taken into account. Any discrepancies will be examined within the scope of supervision – where required, additional measurements (special measurements) are initiated for clarification. In addition, the correct performance and balancing of emission monitoring are verified by means of measurements carried out by an independent measuring institution.

Article 15: Progress and changes since 2007

In the reporting period, the revision of different guidelines and regulations to adapt them to the regulations of the Radiation Protection Ordinance and to take the current state of the art in science and technology into account was continued.

In doing so, the guideline for the determination of body doses from internal radiation exposure [3-42.2] and the safety standard [KTA 1301.2] on the planning of radiation protection measures during operation and on the performance of modifications in nuclear power plants were revised and further developed in order to improve protection of the personnel.

For improved monitoring of the discharge of radioactive materials into the environment, safety standard [KTA 1504] was updated.

In the reporting period, the regulatory guidance instruments on radiation protection were updated to a considerable extent.

Article 15: Future activities

Current and future activities concern, at present, the introduction of electronic personal dosimeters in the German official dosimetry and the update and further elaboration of general administrative provisions for calculating the radiation exposure of the public resulting from the discharge of radioactive material and for incidents during the decommissioning of nuclear facilities.

16 Emergency preparedness

ARTICLE 16 EMERGENCY PREPAREDNESS

1. Each Contracting Party shall take the appropriate steps to ensure that there are on-site and off-site emergency plans that are routinely tested for nuclear installations and cover the activities to be carried out in the event of an emergency.
For any new nuclear installation, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body.

2. Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the States in the vicinity of the nuclear installation are provided with appropriate information for emergency planning and response.

3. Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.

Structure and objectives of emergency preparedness

Nuclear emergency preparedness comprises on-site and off-site planning and preparedness for emergencies (→ Figure 16-1).

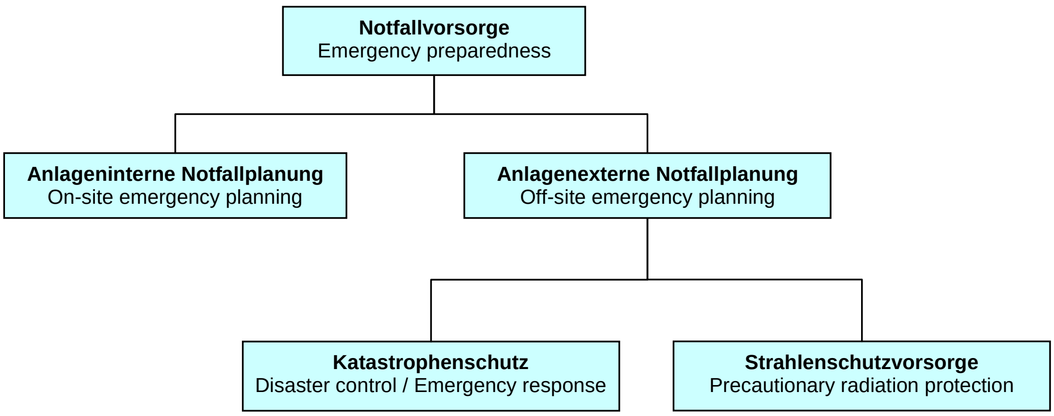


Figure 16-1 Structure of emergency preparedness

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

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

In Germany, the International Nuclear Event Scale (INES) is used for the classification of events at nuclear plants with radiological or without radiological significance. The classification of the different event groups of the INES according to the categories of off-site emergency planning, i.e. disaster control and precautionary radiation protection, is included in Table 16-1.

Table 16-1 Grouping of events for off-site emergency planning

	Event	Classification according to INES scale	Classification disaster control vs. precautionary radiation protection
domestic	Incident	3	Precautionary radiation protection
	Accident	4 to 7	Disaster control (local site area) Precautionary radiation protection
abroad	Incident (neighbouring foreign country)	3	Precautionary radiation protection
	Accident (neighbouring foreign country)	4 to 7	Disaster control (local site area) Precautionary radiation protection
	Accident (far away foreign country)	4 to 7	Precautionary radiation protection

16 (1) Emergency preparedness, emergency plans

Legal and regulatory requirements

Based on the regulations of the Atomic Energy Act [1A-3], the Precautionary Radiation Protection Act [1A-5], the Radiation Protection Ordinance [1A-8] and the disaster control laws of the *Länder*, planning of emergency preparedness is described by the subordinate regulations and by recommendations.

The measures to cope with emergencies (→ Article 19 (iv)) implemented by the plant operator and laid down in the alarm regulation contained in the operating manual and the accident management manual are based on recommendations of the RSK and a joint recommendation of RSK (Reactor Safety Commission) and SSK (Commission on Radiological Protection) [4-2] which includes the alarm criteria which, when reached, require alerting of the disaster control authorities. In addition, there are the reporting criteria of the Nuclear Safety Officer and Reporting Ordinance [1A-17] for the events to be reported to the supervisory authority (→ Article 19 (vi)).

In off-site emergency planning, the required planning scope of disaster control is established by the Basic Recommendations for Emergency Preparedness in the Environment of Nuclear Facilities [3-15.1].

Principles and explanations are described in the associated Radiological Bases for Decisions on Measures for the Protection of the Population against Accidental Releases of Radionuclides [3-15.2]. As a recommendation jointly prepared by the Federation and the *Länder*, the “Basic Recommendations” [3-15.1] form the basis for planning of disaster control in the vicinity of the plant. They determine, among others, the planning areas, measures and further provision of the authorities and the documents required. At the end of 2008, these were republished in a revised form.

Besides the adaptations due to updates of the nuclear rules and regulations, in this revision, importance was attached to the consideration of “events with rapidly developing accident sequences“ in the planning of measures and to the development of an improved communication and information concept.

The “Precautionary Radiation Protection Act” [1A-5] stipulates the competencies of the authorities of the Federation and the *Länder* in precautionary radiation protection. It specifies the responsibilities in the event of a not insignificant release, i. e. a significant release, of radioactive material and contains regulations concerning

– measuring tasks of federal and *Länder* authorities to monitor radioactivity in the environment,
– establishment of an integrated measuring and information system (Integrated Measurement and Information System for the Monitoring of Environmental Radiation, IMIS) including a central federal office for monitoring radioactivity in the environment,
– authorisation to define dose and contamination limits,
– authorisation to ban or restrict the use of foodstuffs, feedingstuffs, drugs or other substances, and
– authorisations concerning cross-border traffic.

While after the reactor accident at Chernobyl, the European Union specified limits of radioactivity in foodstuffs and feedingstuffs immediately to be applied by the EU Commission in a radiological emergency [1F-30], [1F-31], general administrative provisions [2-5] and [2-6] were passed at the national level for verifying the compliance with the limits.

A guideline important for determining the situation is the Guideline on Emission and Immission Monitoring [3-23] which specifies, in addition to the necessary measurements during normal operation, kind and scope of the measuring tasks in case of incidents and accidents (→ Article 15).

Tasks and competencies

On-site emergency planning is a duty of the operator of a nuclear installation. Off-site emergency planning falls within the competence of the authorities of the *Länder* and the Federation (→ Figure 16-2).

Operator of the nuclear installation

According to the protection provisions of the Atomic Energy Act [1A-3] und Section 51 of the Radiation Protection Ordinance [1A-8], the operator is responsible - within the framework of on-site emergency planning - to keep the risk of potential hazards for man and the environment as low as possible in case of incidents and accidents. The measures of the operator are divided into preventive and mitigative measures. Main objective of the preventive measures is to reach and maintain a plant condition which cannot lead to dangerous consequences. The mitigative measures serve for limiting consequences.

In case of an emergency, the operator immediately informs the competent authorities as soon as the specified prerequisites for an alarm are fulfilled. For this purpose, detailed alarm criteria, as part of the operating manual, are available that comply with the specifications of a joint recommendation of the RSK and the SSK [4-2]. The operator is obliged to make information necessary for averting danger available to the authorities in time and appropriate to the situation, to support the authorities in assessing the situation and to advise and support them in taking decisions on protective actions for the public.

The emergency plans of the plant operators' ensure that these measures can be taken without any undue delay.

Authorities of the *Länder*

Pursuant to Article 70 of the Basic Law [1A-1], averting of danger by disaster control is a task of the *Länder* which, to this end, passed the disaster control laws. The implementation falls under the responsibility of the authorities of the interior of the *Länder* and, depending on the respective *Land*, is delegated to the regional or also to the local level. The nuclear supervisory authorities and the radiation protection authorities of the *Länder* provide their support (→ Figure 16-2).

Authorities of the Federation and the *Länder*

As in case of a nuclear accident, large areas outside the area requiring disaster control measures may be radiologically affected below the danger threshold, precautionary radiation protection measures are necessary for these regions, too. In such cases, close co-ordination between the *Land* authorities responsible for disaster control and the federal authorities responsible for radiation protection is required. However, in order to protect the public, the averting of danger (disaster control) ranks on principle higher than precautionary radiation protection. This is particularly important when it comes to the specification of primary protective measures and the distribution of resources.

In case of need, the BMU makes its resources available for providing support and advice to the *Länder*. These resources also comprise the BfS and GRS as well as the BMU advisory committees RSK and SSK.

To ensure a uniform approach in the planning and possible implementation in the case of an event, the BMU developed, with the support of the Commission on Radiological Protection and in co-operation with the *Länder*, the Basic Recommendations for Emergency Preparedness in the Environment of Nuclear Facilities [3-15.1], the Radiological Bases for Decisions on Measures for the Protection of the Population against Accidental Releases of Radionuclides [3-15.2] and the Recommendations for the Planning of Emergency Control Measures by the Licensees of Nuclear Power Plants [3-31].

Within the framework of precautionary radiation protection, the Federation is authorised to specify limits and measures. However, as far as events with exclusively regional impact are concerned, the *Land* authority competent for precautionary radiation protection may determine measures to be taken for preventive health protection. By means of the Integrated Measurement and Information System for the Monitoring of Environmental Radiation (IMIS) [2-4], the Federation monitors and assesses the radiological situation in Germany both during routine operation and under incident and accident conditions, but in this case, measurements and samples will be taken more frequently (→ Article 15).

The BMU is responsible for the fulfilment of the international information and reporting obligations, e.g. for the implementation of the Convention on Early Notification of a Nuclear Accident [1E-2.4], the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency [1E-2.4] and the information exchange for radiological emergencies according to bilateral agreements.

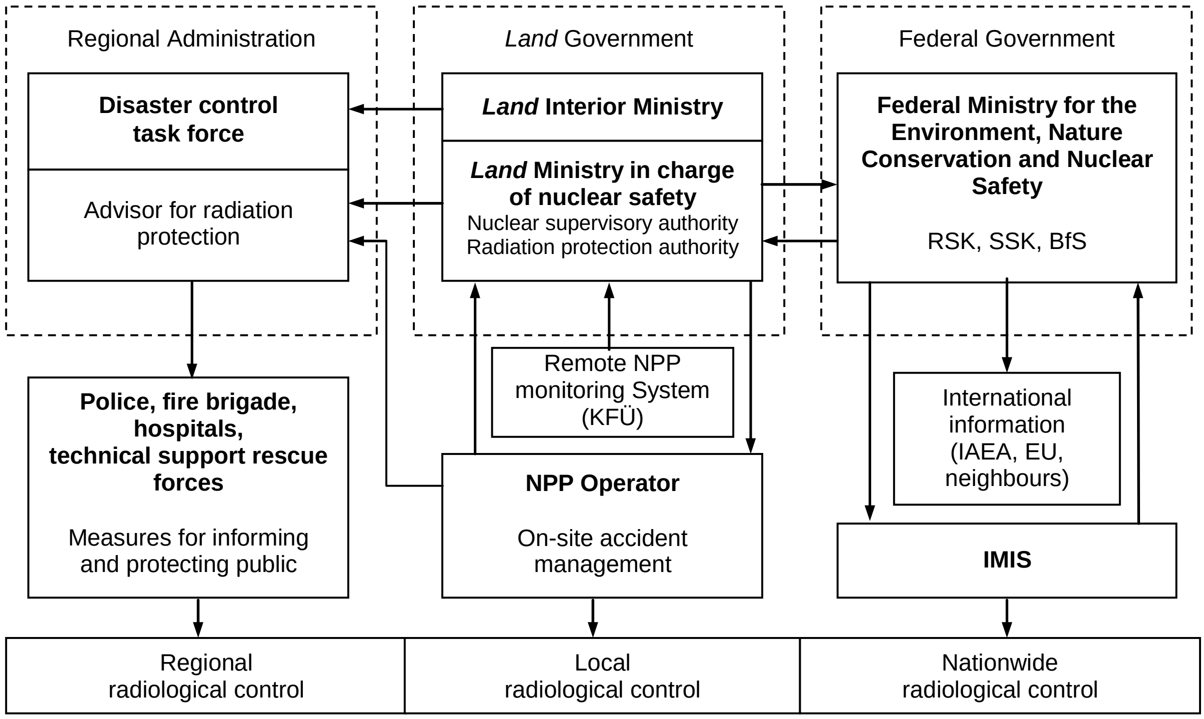


Figure 16-2 Emergency preparedness organisation

Emergency plans and alerts

The alarm regulation of the plant operator includes the regulations on alerting in emergencies. It is part of the operating manual and belongs to the safety specifications. For coping with emergencies, the plant operator establishes a crisis management team. The individual organisational regulations are described in a separate document, the accident management manual (→ Article 19 (iv)).

In the reporting period, the Nuclear Safety Standards Commission (KTA) prepared specifications on the content and design of the accident management manual which are compiled in the draft safety standard [KTA 1203] (→ Article 7 (2i)).

In their entirety, the regulations mentioned represent the emergency plan of the plant operator, which includes, among others,

- measures to make emergency organisation operable,
- criteria for alerting the responsible authorities,
- technical measures for prevention and mitigation of damages,

- measurement programmes for determining the radiological situation, and
- measures for efficient communication and co-operation with external parties, such as the responsible authority, and for informing the public.

Assistance is provided by the crisis management team of the plant manufacturer and by the Kerntechnischer Hilfsdienst GmbH (a permanent organisation jointly installed by the operators of German nuclear power plants). The crisis management team of the manufacturer advises the plant operator in technical questions of situation assessment and restoration of safe plant condition, while the Kerntechnischer Hilfsdienst with its manipulators and measurement equipment may be employed at the site inside and outside the plant. In addition, contractual agreements exist between the plant operators on mutual support.

The responsible disaster control authorities prepare special disaster control plans for the vicinity of the plants. They continuously update the plans and review them at regular intervals (in principle annually). Primary objective of the planning of disaster control is, in case of accidental release, to prevent or mitigate direct consequences from the accident on the public. The content of the planning is based on the “Basic Recommendations” [3-15.1]. The disaster control plans focus on the co-action of the planning of the disaster control authorities and of measures of the plant operator and on the implementation of the measures for protection of the public. Moreover, part of the planning are the measurements required for determining the situation.

In the revised version of the Basic Recommendations for Emergency Preparedness in the Environment of Nuclear Facilities [3-15.1], the planning zones which formerly covered an area of up to 25 km were amended by a long distance zone of up to 100 km. In the long distance zone, the distribution of potassium iodide tablets (iodine tablets) to children and youths under the age of 18 as well as to pregnant women has to be prepared and it has to be ensured that the warning against the consumption of freshly harvested foodstuffs can be distributed without delay.

For initial medical care and decontamination of the public and task personnel affected by a release, emergency care centres are to be provided. The regulations on the design and operation of these emergency care centres and a list of medical doctors willing to provide their services in these centres are to be included in the special disaster control plans. To this end, the SSK recommendations on medical measures in case of radiological accidents [4-11] and, in particular, on medical measures in case of nuclear power plant accidents [4-10] are available. The recommendations were published anew in 2007 in revised form.

Decisions going beyond this planning in terms of space and time are taken within the framework of precautionary radiation protection by the emergency organisation of the BMU.

In this respect, the measure strategies and reference values as defined in the Catalogue of Measures [4-3] serve as decision basis. In the Catalogue of Measures, the recommendations of the “Radiological Bases” [3-15.2] and the maximum permitted levels of the EU n regarding the radioactive contamination of foodstuffs and of feedingstuffs [1F-4.8, 1F-4.9]] are considered. If necessary, disaster control measures are also implemented by the disaster control authorities outside the planning area thus complementing the measures of precautionary radiation protection.

An important aspect of planning is the information transfer between the authorities and, in particular, the alerting of the authorities by the plant operator. In this respect, RSK and SSK recommended criteria for alerting the disaster control authority by the operator of a nuclear installation [4-2, 4-2.1]. According to these, the plant operator defines in the alarm regulation plant-specific emission and immission criteria and technical criteria for early warning or an emergency alert which, when reached, require alerting the disaster control authorities with specification of the respective alert level. Here, the technical criteria, e.g. very high temperature or low water level in the reactor pressure vessel (RPV), are of particular importance, since they give an early indication to the violation of safety objectives and allow rapid alerting. In addition, alerting the disaster control authorities is also possible by the responsible supervisory authority.

For nuclear power plants abroad that may, due to their proximity to the border, require disaster control measures in German territory, a special disaster control planning is performed in the same way and in agreement with the neighbouring countries concerned.

Situation assessment

The determination of the situation is performed at a radiological situation centre with the available information about plant state, meteorological situation and emission and immission situation. First, it is based on prognoses and later increasingly on measurement in the surrounding area.

In the pre-release phase, the radiological situation to be expected in the vicinity of the plant is estimated on the basis of forecast data of the source term and the meteorological situation. Use is made of the decision support system RODOS of the BfS in combination, where appropriate, with the remote monitoring system for nuclear power plants (KFÜ) of the *Land* (→ Article 15). As an alternative, specific systems are applied by the individual *Länder*. RODOS is able to calculate local and regional consequences of releases as well as the effect of protective actions, thus making available situation information and impact assessment to the authorities as decision support. Data on the source term are provided by the operator based on his expectation on the situation. Meteorological data required for the systems result from data measured at the site with KFÜ and the numerical weather forecast of the German Meteorological Service, the Deutscher Wetterdienst (DWD).

In the release phase, the plant operator determines the source term, also additional data of the KFÜ may be available. In this phase, there are also data for assessment of the radiological situation available. These data will be obtained from the local dose rate probes of the KFÜ and from the integrated measuring and information system IMIS, both permanently installed in the vicinity of the plant; in addition, as the case may be, first data of measuring teams will be available. Here, again, the decision support systems described are applied. As soon as data are available according to the measurement programmes provided (→ Figure 16-3), the situation predicted is checked and adapted to the situation determined by measurements.

In the post-release phase, the measurement and sampling services of the plant operator and of the authorities (by independent measurement organisations) provide data for the determination of the radiological situation, in accordance with the requirements of the Guideline on Emission and Immission Monitoring [3-23], supplemented by simple follow-up measurements of radiation detection teams. The soil contamination in the more distant surroundings of the plant and the identification of areas with increased dose rate (hot spots) is shown by means of aircraft hosted gamma spectrometry. All involved teams performing measurements are led by the radiological situation centre.

The development of the wide-range radiological situation in Germany is determined and presented by means of the IMIS which provides information used as support in taking decisions on measures of precautionary radiation protection.

The necessity to inform a large number of authorities and organisations about the current situation in case of a radiological event at short notice and in an effective manner led to the nationwide introduction of the internet-based situation display system ELAN by which situation information and additional data and information are provided for the competent authorities and organisations connected to the system through a secured server connection.

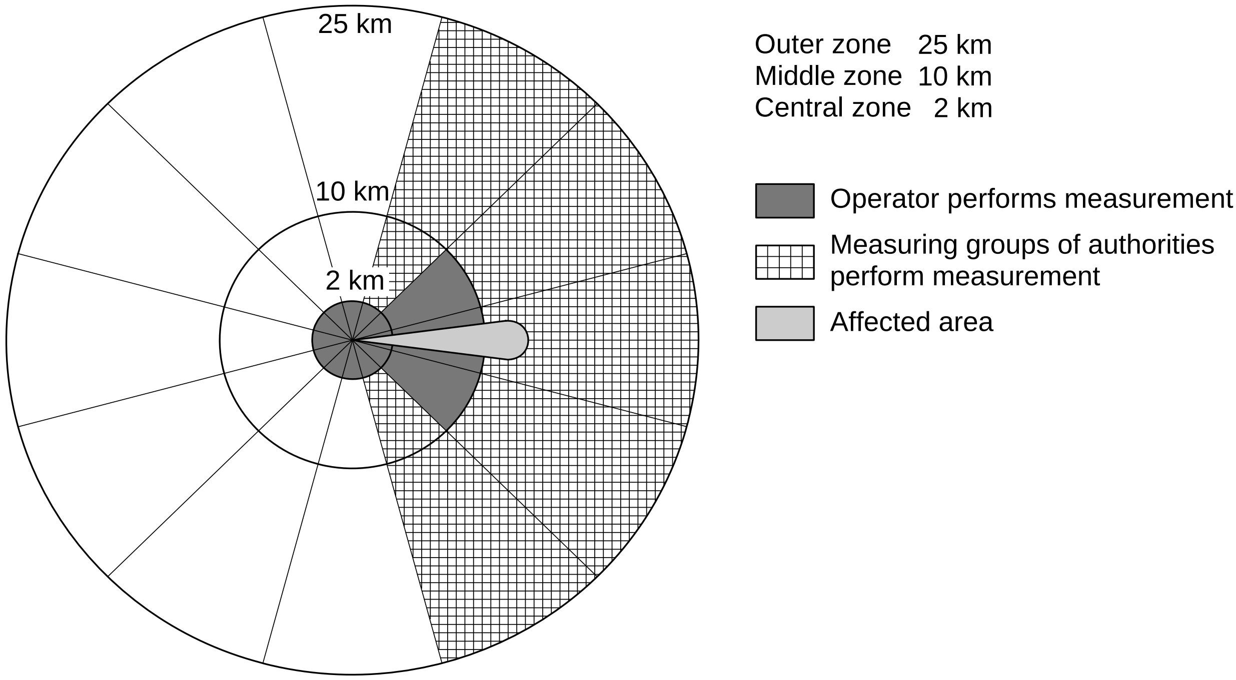


Figure 16-3 Areas of the different measuring and sampling teams

In addition to the computer-based system RODOS, two documents are available: the "Guidance for the expert advisor for radiation protection of disaster control management in case of nuclear emergencies" [4-4] with the associated explanatory report [4-4.1] and the so-called Catalogue of Measures [4-3] "Survey of Measures for the Reduction of Radiation Exposure after Events with Significant Radiological Consequences" (Vol. 1 and 2) which provide additional help and support.

The "Guidance for the expert advisor for radiation protection" especially aims at the situation assessment within the disaster control and is available as computer-based version.

In addition to disaster control measures, the Catalogue of Measures [4-3] also deals with preventive health protection and here especially with measures in the area of agriculture. It documents, among others, derived target and reference values as decision basis. At the end of 2007, the Catalogue of Measures was readopted by the SSK in an updated form. Besides information on decision strategies in the agricultural area, information on waste management options and problems in the area of processing and commercialisation of contaminated agricultural products were included with regard to questions of their acceptance by the consumers.

Off-site measures

Criteria for protective actions

For the determination of criteria and the decision on measures of disaster control, the following objectives are applicable:

- Severe deterministic effects shall be avoided by measures for reducing the individual radiation dose to limits below the threshold doses for these effects.
- The risk of stochastic effects for individuals shall be reduced by appropriate measures.
- The measures for the persons affected shall provide more benefit than harm.

The “Radiological Bases” [3-15.2] explain, in particular, the intervention reference levels (as pre-defined planning values) as thresholds for consideration of the implementation of appropriate disaster control measures to reach the objectives mentioned in case of radionuclide release after a nuclear accident. In case of an event, the intervention levels applied are derived from these reference values, taking into account the current boundary conditions and optimisation considerations.

Further, the “Radiological Bases” explain the transition in Germany from the bandwidth or two threshold concept recommended in ICRP Publication 63 to the initial value concept as described in the IAEA Basic Safety Standards No. 115 where the use of measure-specific intervention reference levels are recommended as initial values which already consider general optimisation considerations regarding the decision. These correspond to the lower threshold of the interval of the two threshold concept stated in the ICRP Publication 63. Potential doses are referred to as decision basis. The concept of the avoidable dose formulated by ICRP is not used as decision basis for short-term measures for reasons of practicability.

Table 16-2 includes the intervention reference levels (thresholds for investigating the initiation of protective actions) for protective actions specified in the “Radiological Bases”. Other criteria referred to within the framework of precautionary radiation protection are the maximum permissible levels of the EU for activity concentrations in foodstuffs [1F-30] and [1F-31].

Table 16-2 Intervention reference levels for protective actions

Protective action	Intervention reference level		
	Thyroid dose	**Effective dose**	**Explanations on integrations periods and exposure paths**
Sheltering		10 mSv	Sum of effective dose from external exposure within 7 days and committed effective dose caused by the radionuclides inhaled within this period
Taking iodine tablets	50 mSv children and teenagers under age 18 and pregnant women 250 mSv persons of age 18 to 45		Thyroid dose caused by the radio-iodine inhaled within 7 days
Evacuation		100 mSv	Sum of effective dose from external exposure within 7 days and committed effective dose caused by the radionuclides inhaled within this period
Long-term resettlement		100 mSv	Effective dose from external exposure caused by radionuclides deposited on the ground and other surfaces within 1 year
Temporary resettlement		30 mSv	Effective dose from external exposure within 1 month

Specifications on radiation protection of the task forces in case of an event deployed as plant personnel, safety and rescue personnel (e.g. police, fire brigade, ambulance staff, physicians) or for specific work (e.g. measurements, transports, repairs, construction works) are included in the Radiation Protection Ordinance (Section 58 and, in particular, Section 59) and the “Radiological Bases” [3-15.2] (→ Table 15-1). These are considered in the relevant fire service regulations [4-5] and the police service regulations [4-6].

Protective actions in the area affected for averting of danger

Off-site emergency planning refers to the preparation and performance of measures for protecting the public from the effects of radionuclide releases caused by incidents or accidents and leading to contaminations and increased radiation exposure.

With priority for implementation of these objectives, the short-term measures

- sheltering,
- taking iodine tablets,
- evacuation, and
- bans on the consumption of fresh, locally produced foodstuffs

are planned as part of disaster control and, if appropriate, joined by supplementary and accompanying measures (e.g. pre-distribution of iodine tablets).

The measures “sheltering” and “evacuation” are pre-planned for an area with a radius of up to 10 km around the nuclear power plant. For this purpose, the intervention reference levels specified in Table 16-2 are taken as a basis.

For the measure “taking iodine tablets”, the tablets are, depending on the planning area, pre-distributed or held in stock locally. Instruction sheets for informing the public on the use of iodine tablets are contained in the “Radiological Bases” [3-15.2].

The Commission on Radiological Protection (SSK) recommended that iodine tablets are pre-distributed to households for all persons under age 45 who live in a radius of 0 to 5 km around the nuclear power plants and pre-distributed to the households or held in stock at several points in the communities (e.g. town halls, schools, hospitals, businesses) in a radius of 5 to 10 km. In doing so, the task forces have to be considered, too. For a radius of 10 to 25 km, it is recommended to hold iodine tablets in stock in the communities or in suitable facilities. The realisation of distribution and stockpiling is the responsibility of the *Länder*.

In a radius of 25 to 100 km, the iodine tablets are held in stock for children and youth under age 18 and pregnant women in eight central stores. For event-related distribution from these stores for the radius of 25 to 100 km area, a concept was developed and implemented by a joint Government - *Länder* working group.

In addition to these measures, to prevent incorporation doses by ingestion of freshly harvested foodstuffs, a precautionary warning against consumption of such foodstuffs will be issued. This precaution will be adapted to the current situation as soon as corresponding data from measurements are available.

Beyond these protective actions, the “Basic Recommendations” [3-15.1] include a list of further measures to be considered in the planning:

- Warning and informing the public
- controlling, regulating and restricting road traffic,
- establishment and operation of emergency care centres for decontamination and medical care as well as treatment of the public and task personnel affected,
- initiating traffic restrictions for rail, waterway and, where required, air traffic,
- informing the water catchment bodies,
- closing contaminated water catchment points,
- warning the public against using water and against aquatic sports and fishing,
- informing waterway traffic,
- closing heavily contaminated areas,
- ensuring food supply,
- ensuring water supply,
- providing the animals with feed, in special cases relocation; where required, killing and disposal of heavily contaminated animals,
- decontaminating traffic routes, houses, equipment and vehicles, and
- preventing the putting into circulation of contaminated foodstuffs and feedstuffs.

Some of these measures also serve the purpose of precautionary radiation protection and are taken according to the Catalogue of Measures [4-3].

<u>Protective measures of precautionary radiation protection for risk minimisation</u>

In those areas where disaster control measures are not justified, the measures of precautionary radiation protection serve to reduce the radiation exposure of the public.

One focal point of the Catalogue of Measures [4-3] developed for this purpose are measures of precautionary radiation protection in form of recommendations for protective actions for the public and a large number of measures in the area of agriculture to prevent or reduce contamination of agricultural products and agricultural surfaces. The measures in the agricultural area are structured, as the situation demands, according to the accident phases (before and during passage of the radioactive cloud; after passage of the cloud) and, in particular, oriented to the limits of the EU [1F-4.8] for activity in foodstuffs. In addition, the catalogue contains information and measures for disposal as well as concretisations of the decision making philosophies and the assessment of the acceptance of measures in the agricultural area. So, e.g., the planning of measures has to consider that the use of contaminated agricultural products will be limited for acceptance reasons and thus disposal will be of more importance than processing with the aim of decontamination.

Other measures of precautionary radiation protection taken into consideration also comprise temporary and long-term resettlements (→ Table 16-1).

On-site measures

The operator of a nuclear power plant is responsible for the performance of all on-site measures for coping with emergencies. This also includes alerting of the competent authority according to the alert plans provided for it. Procedures to be taken in case of abnormal operation, incident or accident situation are explained in Article 19 (iv). Measures to reduce the probability of severe accidents (preventive accident management measures) or measures to mitigate the consequences of severe accidents with core damage (mitigative accident management measures) were taken into account during design and construction of the facilities or were subject to backfitting activities. They are dealt with in Article 14(i) and Article 18 (i).

Exercises

<u>Training</u>

In order to be able to perform the protective actions required in the case of an event effectively, the persons involved in coping with the crisis have to be properly, qualified and trained. Therefore, great importance is attached to on-site and off-site training of task personnel.

This applies, in particular, to the preparation of the plant personnel and especially of the responsible shift personnel for coping with an emergency at the plant [3-2, 3-38, 3-39, 3-65].

For external task personnel, qualification and training are performed task-specifically in the respective organisations.

<u>Exercises of the plant operator</u>

The measures provided by the plant operator are trained, checked and further developed by means of exercises performed at regular intervals. Exercises involving the emergency organisation of the plant operator are generally performed by the operating organisations once a year per NPP unit according to the RSK statement “Allgemeine Anforderungen an Krisenstabsübungen“ on general requirements for crisis management team exercises of 18.03.1992 (268th meeting).

In order to be able to perform exercises as close to reality as possible, the accident scenarios on which the exercises are based are prepared generally in very detail. Typical exercise scenarios are events with loss of coolant, external events (earthquake, flood, aircraft crash, etc.), anticipated transients without scram (ATWS) and station blackout. In order to simulate dangerous situations according to the objectives of the respective exercise, these events are combined with inadequate core cooling and/or residual heat removal and/or inadequate containment isolation. As before, events in the field of physical protection are included in the exercise programme of the plant operators. In detail, the exercises may aim at, e.g.: internal and external alerting, application and, at the same time, review of the practicability of the written operating procedures and, as far as possible, of the technical provisions, detection and actuation of alarms (early warning, emergency alert); documentation of the processes, measuring campaigns, rescue of persons from radiation-controlled areas, build-up of decontamination facilities; organisational and work procedures of the crisis management team and public relations.

The exercises are performed at the plants as realistic as possible, making increasingly use of the nuclear power plant simulators.

The annual exercises are generally limited to the nuclear power plant site. At larger intervals, the interaction between the emergency response team of the manufacturer, the Kerntechnischer Hilfsdienst and the authorities responsible for off-site emergency planning is practised.

As a matter of principle, the authorities are informed about on-site exercises and often participate as observers on the ground. The number of exercises in which the technical departments of the site and the authorities practice their cooperation and communication is increasing. This cooperation is complemented by supervisory visits and the performance of, for example, on-site activities by the authority that are supervisory priorities. On the part of the operators, exercises are introduced and discussed within the scope of the exchange of experiences and feedback, e.g. in VGB Working Panels. Exercises of other plants are also observed across locations and sites.

In addition to exercises performed under participation of the supervisory authority and the authorised expert, also internal exercises on accident management including the interfaces to disaster control are carried out.

Among other things, exercises

- on fire protection,
- on availability,
- on plant security and physical protection (other interference by third parties),
- on a beyond design basis accident during shutdown,
- of the crisis management team,
- of the medical and rescue service

were carried out.

These exercises partially took place at a simulator also including the situation centre and the remote monitoring system for nuclear reactors of the *Land*.

Exercise reports are prepared on the course of the on-site exercises and essential findings are included in the emergency planning. During training measures, the staff receives a feedback. The documentation on the accident management is regularly reviewed with regard to completeness and correctness.

The exercises on accident management and disaster control showed that the provided measures meet the requirements.

Exercises of the authorities at the national level

The disaster control authorities at the *Länder* level and at the regional level regularly perform large-scale disaster control exercises at the nuclear power plant sites, albeit at intervals of several years due to the considerable efforts and expenditure required. In addition to the competent authorities and the technical advisory commissions, the plant operator also participates in the exercises. Active involvement of the potentially affected population is normally not foreseen.

Objectives of these exercises are the improved interaction of the different organisations and authorities involved in emergency management and the assurance of effective co-operation in the disaster control and precautionary radiation protection. Another objective of the exercises is the practical deployment of forces within the framework of measurements and special support services, such as testing of temporarily established emergency care centres, dedicated to decontamination and medical services for the public, and the communication and co-operation of the different authorities and organisations involved.

The scenario of the exercises focussing on off-site measures is generally developed by the authority. The exercises cover the main tasks within the disaster control management. This includes, in particular, the assessment of the radiological situation, nature and scope of measures, command and control of the task forces and information of the public.

The focus of the exercises performed so far has been on scenarios with postulated release of radioactive substances into the environment without considering the actual accident sequence in the plant. However, there is an increasing tendency to perform site-specific integrated exercises in which the plant operator and the competent authorities of potentially affected *Länder* perform an exercise with a plant-specific scenario.

The objective of these exercises is the integration of the processes in the plant into the exercises and to thus practice the associated cooperation and communication between operator and responsible authorities.

In May 2009, a command post exercise (CORE 2009) was carried out for the emergency organisation of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the Federal Office for Radiation Protection during which the comprehensive cooperation of the BMU command posts was practiced with the support of GRS and BfS. It is planned to conduct further exercises of this kind on a regular basis.

To improve the disaster control measures, the main emphasis of the exercises is, on the one hand, on systems that are based on the use of modern information technologies. These include, for example, a joint measurement centre, a management and information system for disaster control data or an electronic situation display with corresponding communication concept. On the other hand, the exercises are increasingly geared towards the overall cooperation between the different organisations that are in charge of the control of an accident. Additionally, informing the public becomes increasingly important as a main focus of exercises.

Furthermore, at the national level, exercises relating to radiological events, e.g. in connection with terrorist attacks, are increasingly conducted. Examples are the table-top exercise FEBREX 2007 of the BMU and the participation of BMU and BfS in a command post exercise of the Federal Ministry of the Interior and the Federal Office of Civil Protection and Disaster Assistance in November 2008. At the *Länder* level, joint exercises of radiation protection authorities, radioactivity measuring institutions of the *Länder* and *Länder* Offices of Criminal Investigation take place on a regular basis.

Here, particular emphasis is to be put on the LÜKEX exercise 2009/2010 which was held, after a one-year preparation period, by the participating authorities of the federation and the participating *Länder* in January 2010. The exercising organisations and command posts of all levels were confronted with, among other things, radiological emergency situations due to terrorist attacks and had to cope with them both technically and with regard to information policy.

<u>Participation in exercises at the international level</u>

As part of international co-operation and on the basis of bilateral contracts, representatives from authorities of neighbouring countries are actively involved in exercises concerning plants near the border, or at least participate as observers.

One example of cross-border cooperation is the participation in the CONVEX-3 exercise that took place from 9 to 10 July 2008. Due to the long distance to the facility chosen for the exercise in Mexico, no direct radiological consequences were to be expected for Germany. Therefore, the exercise was used to practice communication and cooperation between the Federal Ministry for the Environment as national competent authority in charge and the Germany’s neighbouring countries as well as with Mexico, the country affected by the accident. In addition, other German organisations that would be involved in such a case were included in the exercise. In particular, the Federal Foreign Office participated in a nuclear exercise scenario for the first time.

Exercises with scenarios of a radiological event are also carried out at the international level. One example for this is the table-top exercise jointly executed by Germany and Austria within the scope of the OECD/NEA INEX-3 exercise series in September 2005. The objective of this exercise was the co-ordinated cross-border emergency management in case of a radiological event (combustion of a caesium-137 source).

Germany participates in the preparation of the new INEX programme and will presumably actively take part in the INEX-4 exercise in 2010.

On principle, BMU representatives take part - in line with their respective responsibilities - in the regular exercises of the EU (ECURIE exercises), the IAEA (CONVEX exercises) and the OECD/NEA (INEX exercises), in which supporting agencies, other federal ministries and the relevant *Länder* authorities also participate depending on the situation.

Regarding further development and harmonisation of nuclear emergency preparedness regulations at an adequate high international level, representatives of the BMU and other organisations participate for Germany in the relevant commissions at OECD/NEA, IAEA and the EU as well as in a working group on radiation emergency preparedness (Emergency Preparedness Action Levels, EPAL) of the European association of the top regulators in the field of radiation protection (Heads of European Radiation Control Authorities, HERCA).

In *Länder* with nuclear installations close to the border, cross-border disaster control exercises are conducted at longer intervals. In November 2008, for example, a joint disaster control and measuring exercise was carried out with Fessenheim NPP. Besides Fessenheim NPP, German and French authorities took part in the exercise. The exercise was jointly prepared in close co-operation by the French and Germany authorities.

Regulatory review

According to the RSK statement “Allgemeine Anforderungen an Krisenstabsübungen“ on general requirements for crisis management team exercises of 18.03.1992 (268th meeting), the plant operators have to perform an emergency exercise per NPP unit and year using beyond design basis scenarios. The topic emergency provisions is an independent area of inspection and comprises, among other things, the control of the preparation, execution and evaluation of emergency exercises of the operators. The preparation, execution and evaluation of the emergency exercises of the operators are thus regularly reviewed by the supervisory authorities responsible for the respective plant.

In Baden-Wurttemberg, an in-depth review of the topic preparation, execution and evaluation of emergency exercises of the operators was performed in recent years within the scope of a supervisory priority. The result of this review was that also in emergency situations the operators control their installations.

The nuclear emergency preparedness plans of the *Länder* are continuously adapted to the respective, nationally binding recommendations of the expert committees (e.g. SSK) and of the competent local authorities and governments. In addition, to further optimise the management structure and protective measures, the experiences gained in the regularly held exercises are also taken into account in the planning.

16 (2) Informing the general public and neighbouring countries

Informing the public

The requirements of the EURATOM directive regarding the information of the public in case of a radiation emergency [1F-4.5] have been incorporated in Sections 51 and 53 of the Radiation Protection Ordinance [1A-8]. The main contents of the information of the public are specified in Appendix XIII of the Radiation Protection Ordinance where distinction is made between information to be issued to the public in advance as preparation for a radiological emergency and the relevant information in case of a concrete emergency according to Section 51 (2) of the Radiation Protection Ordinance.

The most important issues about which the public in the vicinity of a plant has to be informed at least every five years concern, among others,

- basic terminology and related explanation on radioactivity and its impacts on humans and the environment,
- radiological emergencies and their consequences for the public and the environment, including planned rescue and protective actions,
- information on how the affected persons will be alerted and how they will be continually updated on the development of the situation, and
- information on how the affected persons should behave and what they should do.

This information is realised by means of a brochure, financed by the plant operators, which is posted to the public living in the vicinity of a nuclear installation in co-ordination with the disaster control authorities.

In case of a safety-relevant event at a nuclear installation leading to a radiological emergency in the surrounding area, the competent authorities inform the potentially affected public without any delay according to Section 51 (2) of the Radiation Protection Ordinance and give information on how to behave including specifications on health protection measures to be taken. The information to be given to the public are summarised in Appendix XIII, Part A of the Radiation Protection Ordinance and concern, among others,

- type and characteristics of the event, in particular origin, dispersion and expected development of the situation,
- protection instructions and measures for certain groups of the population, and
- designation of the authorities responsible for disaster control.

Also in case of pre-alarm level (early warning), respective information are to be given to the public.

In the reporting period, SSK published a “Guideline for the information of the public in case of nuclear accidents” [4-12], which contains suggestions for a concept for further specification. This information concept is to be developed within the scope of the disaster control planning and is part of the special disaster control plans. It is adapted to the respective site-specific conditions and shall be cross-nationally effective, where required.

In addition to regulations concerning responsibilities, it contains procedures according to which the different institutions involved coordinate the contents of their information. Furthermore, it specifies how the citizens are enabled to contact the authorities responsible for disaster control and the media via which the public will be informed. Sample texts on this are laid down in the “Basic Recommendations” [3-15.1]. The suitability of the prepared measures to inform the public is reviewed in the exercises.

Informing the public also means that the disaster control plans, with the exception of personal and security-sensitive information, may be viewed by the public.

Informing the neighbouring countries

In the event of an emergency, the measurement data acquired within the monitoring programmes and the situation assessment of the plant operator will be the basis for reporting in accordance with the EU agreement on rapid information exchange [1F-4.1] and the Convention on Early Notification of a Nuclear Accident [1E-2.4]. They also serve as basis for the information exchange for fulfilling bilateral agreements. This ensures that Germany's neighbouring countries will receive timely information. The measurements routinely performed in accordance with the Guideline on Emission and Immission Monitoring [3-23] are also used for the reports to the EU in accordance with Article 36 of the EURATOM Treaty.

Germany has signed bilateral agreements regarding mutual assistance in the case of an emergency with all of the nine neighbouring countries. Moreover, assistance agreements have been concluded with Lithuania, Hungary and the Russian Federation. Similar agreements with Italy and Bulgaria have been initialled or are in preparation. Due to such agreements, there are direct information and data exchanges at the regional level at nuclear power plant sites near the border between the respective disaster control authorities or organisations for determining the radiological situation.

16 (3) Emergency preparedness of contracting parties without nuclear installations

Not applicable to Germany.

Article 16: Progress and changes since 2007

Within the reporting period from 2007 to 2009, numerous amendments of regulatory documents related to emergency preparedness were performed:

At the end of 2008, the “Basic Recommendations” [3-15.1] were republished in a revised form. Besides the adaptations due to updates of the nuclear rules and regulations, the revision took special attention to the consideration of “events with rapid sequences“ and to the development of an improved communication and information concept. Furthermore, the concept for the provision of iodine tablets was revised and adapted to the current recommendations of the SSK.

The Radiological Bases for Decisions on Measures for the Protection of the Population against Accidental Releases of Radionuclides [3-15.2] were edited and, together with the “Basic Recommendations”, published anew. So, among other things, the changes of the age of children and youths with regard to the dose reference levels for the intake of iodine tablets were included. Also, the information sheets on iodine were updated according to the SSK publication.

The SSK has revised the “Catalogue of Measures” [4-3] and integrated the information and measures for disposal as well as concretisations of the decision making philosophies and the assessment of the acceptance of measures in the agricultural area.

According to the revised “Basic Recommendations”, the disaster control authority has to develop a substantiated concept to inform the public which is to be included in the disaster control plans. To this end, the SSK prepared a guideline [4-12] and published it in 2008. This guideline contains suggestions and instructions for the preparation of the required concept.

In addition, the SSK further developed the concepts for medical measures in case of radiological accidents [4-11] (especially for the medical measures in case of accidents at nuclear power plants [4-10]).

Within the scope of the KTA activities, the draft safety standard [KTA 1203] “Requirements for the Accident Management Manual” was prepared.

The operators specified criteria for the determination of potential radiological impacts as information for the off-site disaster control planning. The corresponding estimations refer to analyses of the event sequences,

- that are considered in the on-site emergency planning and
- during which releases may occur that require disaster control measures in the environment of the plant.

In an emergency situation, these analyses and the assessments of the plant condition by means of the fulfilment of the protection goals are submitted to the disaster control authorities within the scope of an “early warning” and the “alarm”.

Article 16: Future activities

The aim is to further develop technical and organisational co-operation for coping with radiological events.

This includes national exercises under participation of several *Länder*, the integration of external observers and the performance of international exercises in areas near to the border.

It has to be endeavoured that the exercises simulate situations as close to reality as possible, e.g. by means of the increased involvement and use of simulators and by integrating plant-specific sequences in exercise scenarios.

The experiences gained from exercises are to be incorporated into the further development of off-site emergency planning. Moreover, an improved and more extensive information exchange in the radiological emergency management will offer the possibility to increase interaction of the emergency systems at the national (between the Federation and *Länder*) and the international level.

Furthermore, it is currently verified and discussed whether due to new scientific findings, another revision of the content of the “Radiological Bases” [3-15.2] are necessary. Here, the published ICRP recommendation “Recommendations on the protection of man and the environment against ionising radiation” of 2007 (ICRP 103), the UNSCEAR report “Effects of ionizing radiation” of 2006 and the “Basic safety standards for protection against ionizing radiation and for the safety of radiation sources”, which is currently being revised, jointly by the IAEA, ILO, FAO, OECD-NEA and WHO, are to be considered in particular.

17 Siting

ARTICLE 17 SITING

Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented:

i) for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime;

ii) for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;

iii) for re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation;

iv) for consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation and, upon request providing the necessary information to such Contracting Parties, in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation.

In Germany, licences for the construction of new nuclear power plants pursuant to Section 7 (1) of the Atomic Energy Act [1A-3] are no longer granted (→ Article 7). Therefore, the following presentation deals with the procedures as practiced in the past for the plants in operation today. Further, the design against external hazards (→ Article 17(1)) and their re-evaluation (→ Article 17 (3)) are addressed.

17 (1) Site evaluation

Requirements for site selection

The relevant standards and regulations have already been presented in Article 7 (→ Article 7).

Procedures and criteria for site selection

Uniform criteria for the evaluation of sites for nuclear power plants are specified in regulatory guideline [3-12] and are applicable in all *Länder*. This guideline contains, in particular, site-specific criteria important for site selection by the licensee and for the nuclear licensing procedure and, in addition, those criteria pertaining to the suitability of the site with respect to regional planning as well as to nature conservation and landscape conservation.

With respect to nuclear safety, the following issues have been taken into account:

- Meteorology with regard to atmospheric dispersion conditions,
- hydrology with regard to cooling water supply, the discharge of radioactive material via the water path, and the protection of drinking water supplies,
- population distribution in the vicinity of the site,
- seismic hazard and geological subsoil properties,
- external hazards due to flooding, aircraft crash or pressure waves from off-site explosions,

- road transportation infrastructure with regard to site accessibility, and
- distance to military installations.

Design against man-made and natural external hazards

The requirements for the design and for protective measures against external hazards for construction of the German nuclear power plants followed the nuclear safety regulations applicable at that time. In cases where detailed requirements were not yet formulated in the regulations, the specific requirements were defined in the respective licensing procedure. The steps in developing these requirements are described below. The corresponding re-evaluation of nuclear installations is dealt with in Article 17 (iii).

All nuclear power plants where there was a risk of this kind have not only been designed taking into account the usual natural external loads, such as wind and snow, but also floods and earthquakes. In this context, both, nuclear safety standards and conventional civil engineering standards were applied. Depending on the overall cooling concept for the nuclear power plant, the system design resulted also in requirements important to safety for the cooling water supply. It had been verified for the individual site conditions that the cooling water supply was ensured even under unfavourable conditions, e.g. low water in the river or failure of a river barrage.

<u>Design against flooding</u>

Since 1982, the requirements for flood protection measures have been specified in nuclear safety standard [KTA 2207], revised in the years 1992 and 2004. Pursuant to this standard, a permanent flood protection is to be provided. Under special boundary conditions, protection against the difference between the water levels of the flood with an exceedance probability value of 10^{-2}/a and the design basis water level of 10^{-4}/a may also be provided by temporary measures.

The sites of the nuclear power plants are mostly located inland at rivers and, in some cases, at estuaries with tidal influences. In most of the cases, sites have been selected which are located sufficiently high. In all other cases, the structures important to safety were sealed for water tightness and were built with waterproof concrete. Furthermore, the openings (e.g. doors) are located above the level of the highest expected flood. If these permanent protective measures should not be sufficient, mobile barriers are available to seal the openings.

<u>Design against earthquake</u>

Since 1990, the design against earthquakes is based on a design basis earthquake (formerly called “safe shut-down earthquake”) in accordance with safety standard [KTA 2201.1]. The so-called operating basis earthquake, formerly to be considered additionally according to the previous version of 1975, was replaced by an “inspection earthquake” where only the plant condition has to be checked. The design basis earthquake has the largest intensity that, under consideration of scientific findings, could occur in a wider vicinity of the site (up to a radius of about 200 km). Depending on the site, the intensity of the design basis earthquake varies between less than VI and a maximum of VIII on the MSK scale. In the power plants of older construction lines, the seismic qualification of civil structures, components and plant equipment was partly based on simplified (quasi-static) methods which delivered the basic values for the corresponding design specifications. In more recent nuclear installations the newly developed dynamic analyses were also applied.

Safety standard [KTA 2201.1] is in the revision process. Since 2009, a revised version of safety standard [KTA 2201.1] has been available as draft safety standard.

Protection against aircraft crash

Protection against aircraft crash concerns the accidental crash of an aircraft onto safety-relevant plant areas. The protection measures were taken against the background of the increasing number of nuclear power plants in Germany in the 1970s and a high crash rate of military aircrafts in those years. The general basis was the analysis of the crash frequency (the exceedance probability for impacts on safety-relevant buildings is about 10^{-6}/a and plant) and of the loads on the reactor building that would be caused by such a crash. From the mid-1970s onwards, load assumptions were developed for the event of an aircraft crash which were then applied to the design of preventive measures in the nuclear power plants built in the following years for further risk minimisation. Since the end of the 1980s, the crash rate of military aircraft has decreased considerably. This has the effect that the crash frequency today can be assumed to be smaller by about one order of magnitude.

For older construction lines, protection by system design against the consequences of an aircraft craft was improved by the design of buildings and components in interaction with additional auxiliary emergency system physically separated from the actual reactor building. The second-level emergency systems can ensure the safe confinement of radioactive material in the reactor even if important plant components would be destroyed due to external hazards. The spatial arrangement of the buildings ensures that the safety systems and equipment located in the central reactor building and in the second-level emergency systems do not become inoperative due to the postulated events at the same time. The effectiveness of the protection of these plants against aircraft crashes was demonstrated by subsequent reviews of the design margins of the safety-relevant buildings and extended within the framework of backfitting measures. New buildings were designed according to the increased requirements and the measures against induced vibrations improved.

For the newer construction lines, the design against aircraft crash also covered aside from the reactor building further civil structures containing systems necessary for the control of this external hazard (e.g. the emergency feed-water building in newer PWRs). Furthermore, protective measures were taken to account for the vibrations in components and internals induced by pressure waves from aircraft crash, e.g. by uncoupling the ceilings and inner walls from the outer wall or by a special design.

Protection against pressure wave from explosion

The requirements for protecting nuclear power plants against pressure waves from chemical explosions in case of an accident outside of the plant area were developed in the 1970s due to the specific situation of nuclear power plants located on rivers with corresponding ship traffic and transport of explosive goods. The load assumptions - based on a maximum overpressure of 0.45 bar - are specified in regulatory guideline [3-6] and are being applied since its publication independently of the individual site. Furthermore, with respect to possibly larger peak pressure at the accident location itself, a sufficient safety distance is kept from potential sources of explosions (e.g. traffic routes, industrial complexes).

Regulatory measures

After the applicant had pre-selected a site, a regional planning procedure was initiated which preceded the nuclear licensing procedure. This took into account all impacts of the individual project on the public, on traffic ways, regional development, landscape protection and nature conservation. Besides the site characteristics, the design of the nuclear installation against external hazards was checked in the nuclear licensing procedure (→ Article 7 (2) (ii)). Further, investigations were carried out as to whether general public interests oppose the selection of the site. Within the nuclear licensing procedure, the respective competent authorities analysed if the requirements regarding water utilisation, immission control and nature conservation are met. The construction permits and operating licences of the German nuclear power plants have all been granted before the European Directive on Environmental Impact Assessment [1F-1.15] entered into force. Assessments of environmental impacts were exclusively performed according to national law.

In case of licensing procedures within the scope of essential plant modifications, the environmental impacts are assessed, in accordance with the Atomic Energy Act, pursuant to the Environmental Impact Assessment Act.

17 (2) Evaluation of the likely impacts of the nuclear installation on the environment

Requirements regarding the safety-related impacts

With the impacts that an operating nuclear power plant has or could have on the environment and on the people living in its vicinity, distinction is to be made between conventional impacts which would also emanate from other industrial facilities and radiological impacts both during operating conditions of the plant and in case of design basis accidents.

Conventional impacts of the nuclear installation on the environment

The heat input to rivers or water bodies from discharged cooling water during power operation (either from fresh water cooling systems, or from direct-contact cooling systems with wet cooling towers) is not permitted to exceed the limits specified in the licensing procedure. Here, the water law regulations generally prescribe more narrow limits with regard to heating of river than the safety requirements. If, under extreme weather conditions, it is foreseeable that the permissible temperature rise would be exceeded, the respective nuclear installation must reduce its power accordingly.

An individual licensing procedure according to the water law is required with respect to the utilisation of water and to the discharge of cooling water and waste water. This is performed in close co-ordination with the nuclear licensing procedure.

Radiological impacts during operation and design basis accidents

The Radiation Protection Ordinance [1A-8] specifies dose limits for the radiation exposure of the general public to be adhered to during operating conditions and planning values for the radiation exposure during design basis accidents. These are dealt with Article 15.

Implementation of the requirements in the licensing procedure

The construction or essential modification of nuclear installations must also fulfil special requirements under the laws on protection against dangerous conventional environmental effects, e.g. air pollution with toxic or corrosive materials, and noise pollution. Since the early 1990s, these requirements are assessed explicitly on the basis of the Environmental Impact Assessment Act [1F-1.15] (→ Article 7 (2) (ii)). The impacts of the nuclear installation on the environment are comprehensively determined, described and evaluated by this assessment. The objective is to keep any detrimental environmental impact during operation of a nuclear installation as low as possible. In this respect, the provisions of the Federal Immission Control Act [1B-16] must be observed together with its individual ordinances.

17 (3) Re-evaluation of the site-related factors

Measures for re-evaluation

Article 17 (1) describes the design of German nuclear power plants against external hazards. The safety reviews (SRs) which are to be performed every ten years (→ Article 14 (1)) also include a re-evaluation of the protective measures against external hazards, taking the development in the state of the art into consideration. As a result of these reviews, measures have been taken or planned as far as necessary.

The protection against external hazards is assessed on the basis of the Safety Criteria for Nuclear Power Plants [3-1], the RSK guidelines [4-1], accident guidelines [3-33.1] and the relevant KTA safety standards (for the events earthquake, flood, and lightning).

The Safety Criteria for Nuclear Power Plants [3-1] require that all plant components necessary to safely shut down the reactor, to remove residual heat or to prevent uncontrolled release of radioactive material shall be designed to be able to perform their function even in the case of external hazards. In this respect, the following has to be considered in particular:

- External natural hazards, as far as to be considered, such as earthquake, landslide, storm, flood, storm surge,
- external man-made hazards, such as aircraft crash, impact of dangerous and, in particular, explosive substances, and
- disruptive action or other interference by third parties.

The design requirements specified in regulatory guideline [3-33.1] for external hazards distinguish between hazards to be treated as design basis accidents and hazards which, on account of their low occurrence probability, are not considered as design basis accidents, and for which measures must be taken to minimise the risk. Accordingly, the external natural hazards (earthquake, flood, external fire, lightning and other natural impacts) are considered as design basis accidents (→ Article 18 (1)), whereas for the evens aircraft crash and pressure wave or impacts from dangerous materials from events outside of the plant, measures for risk minimisation are to be taken.

Results of site evaluations

Essential developments and more recent evaluations with regard to the external hazards flood, earthquake, aircraft crash and pressure wave from explosion are described below.

Flood

The re-examinations on flood protection in the years 2000 to 2002, initiated by the BMU, showed that the plant-specific specifications on the design basis flood as well as on the technical and administrative protection measures generally were in compliance with the safety standards applicable at that time. However, the results of the examinations also show that the approaches on the determination of the design basis flood as well as the maintenance of the flood protection measures were not implemented uniformly in the different plants. The specific protective measures at the individual sites strongly depend on the respective topographic conditions. Therefore, the individual measures planned or taken result in a heterogeneous picture. For some nuclear power plants, for example, directly located at rivers, an island situation may already occur in case of a flood expected at 10^{-3}/a. For such a situation corresponding organisational and administrative measures are provided.

In order to standardise the procedure for flood protection, safety standard [KTA 2207] was revised and has been available since November 2004 in an updated version. The changes compared with the previous version concern, in particular the specification and determination of the design basis flood. It is now consistently based on an exceedance probability of 10^{-4}/a. Since then, the amended safety standard has been applied to all modification licences where flood protection is concerned. Moreover, it is used as assessment criterion for any kind of deterministic safety review, e.g. within the scope of the legally required safety review (SR) according to Section 19a of the Atomic Energy Act (→ Article 14 (1)).

Earthquake

For some nuclear installations at sites with relevant seismicity a re-evaluation of the seismic safety has been performed due to the ongoing development of methods for seismic hazard analysis and for design verification. In general, the re-evaluations with regard to the design of components showed that, on the basis of more precise seismic input and modern verification methods, the technical equipment of the plants partly has considerable margins with respect to seismic loading. At plants for which a need for upgrading was identified despite of this, comprehensive safety retrofits were performed on the basis of these re-evaluations. Furthermore, new seismic hazard analyses were carried out for all sites within the scope of the erection of on-site interim storage facilities. For nuclear power plants at two sites, also seismic PSAs were carried out.

Aircraft crash

For older plants, a further risk reduction regarding accidental aircraft crashes was achieved by backfitting with physically separated second-level emergency systems that are completely independent from other systems (→ Table 6-2). All in all, the risk contribution from accidental aircraft crash is to be considered as a risk against which measures are to be taken, but the measures of damage reduction of level of defence 4 are sufficient. As regards accidental aircraft crash, some nuclear installations were re-evaluated with regard to the load transfer in conjunction with probabilistic safety assessments.

As results of the probabilistic assessments by the plant operators it was stated that even in the cases where the reactor building does not withstand the loads to be assumed according to the currently applicable rules and regulations, the contribution of such scenarios to damage states with considerable release was all in all assessed to be low.

Pressure wave from explosion

In those cases where the design of nuclear installations did not already account for protective measures against pressure waves from explosion and where such an external hazard cannot be precluded due to the site conditions, corresponding analyses were performed within the framework of the safety reviews.

Regulatory assessments and activities

The safety reviews (SRs) of the plants that are or have to be submitted pursuant to the Atomic Energy Act are reviewed by consultation of expert organisations and using the current guidelines.

17 (4) Consultations with neighbouring countries

International agreements

The legal obligation in Europe for a cross-border participation of the competent authorities [1F-1.15] was transposed into German law by a corresponding amendment of the Nuclear Licensing Procedure Ordinance [1A-10]. Accordingly, the competent authorities of neighbouring countries will be involved in the licensing procedure if a project could considerably affect the other country.

Germany signed the Espoo Convention on Environmental Impact Assessment in a Transboundary Context [1E-1.1]. The European Community also ratified the agreement, however limited to the application of the provisions among the member states.

In accordance with Article 37 of the EURATOM Treaty [1F-1.1], the European Commission will be informed of any plan for discharging radioactive material of any sort. For this purpose, general information on the planned discharge, on the site and the essential characteristics of the nuclear installation are reported to the Commission six months before the competent authority issues a licence permit for the discharge in question [1F-1.5]. This serves to establish the possible impacts on the other member countries. After a hearing with a group of experts, the Commission presents its position on the case of intended discharge.

Bilateral agreements with neighbouring countries

From a very early stage, Germany took up cross-border information exchange in connection with the construction of nuclear installations in the border regions.

At present, bilateral agreements regarding the exchange of information on those nuclear installations built in the border regions exist with seven of the nine neighbouring countries of Germany (the Netherlands, France, Switzerland, Austria, the Czech Republic, Denmark and recently Poland).

Joint commissions for regular consultations on questions of reactor safety and radiation protection were formed with the Netherlands, France, Switzerland, Austria and the Czech Republic.

The information exchange on nuclear installations in the border region concerns the following:

- Technical or other modifications relevant to licensing,
- operating experience especially with regard to reportable events,
- general reports on developments in nuclear energy policy and in the field of radiation protection, and
- regulatory development of the safety requirements especially with regard to accident management measures in the case of severe accidents.

Seen together, the German legal regulations, the bilateral agreements and the joint commissions put neighbouring countries in a good position to independently assess the impacts nuclear installations in border regions will have on the safety of their own country. Article 16 (2) has already dealt with the joint agreements with neighbouring countries regarding information exchange and mutual assistance in the case of emergencies, and with the further agreements entered into with other countries, the IAEA and the EU.

Article 17: Progress and changes since 2007

Safety standard [KTA 2201.1] “Design of Nuclear Power Plants against Seismic Events; Part 1: Principles” has been reviewed since 2005 and has been available as draft safety standard since September 2009. The long processing time resulted from the fact that for the first time probabilistic methods were included in the requirements for the earthquake-related design. Pursuant to the revised version, the design basis earthquake has to be specified with simultaneous consideration of deterministic and probabilistic analyses. The associated seismic events may be indicated for the 50 % fractile if the exceedance probability of the parameters of the design basis earthquake is within the order of 10^{-5}/a. In addition to this fundamental extension of the procedure for the seismic hazard analysis, the requirements concerning the structural and mechanical seismic design were also adapted to the state of the art in science and technology. Among other things, the tripartite classification of buildings, systems and components which has been common and proven in practice was adopted in the regulation (Class I: structures, systems and components that are necessary to achieve the protection goals; Class IIa: structures, systems and components that do not belong to Class I, but for which proof has to be furnished that damages potentially occurring in case of an earthquake and the impacts thereof cannot impair Class I plant components or structural components; Class IIb: other structures, systems and components.)

There have also been further developments in respect of meteorological events. Within the scope of a research project, it was examined (among other things) which impacts the climate change may have on the hazard to nuclear power plants in Germany due to meteorological events. To this end, studies on the impacts of the climate change in Central Europe were exemplarily evaluated and compared with the international operating experience of nuclear power plants in respect of meteorological events. It can be derived from this comparison that for the sites of the German nuclear power plants, it is not to be expected that the hazard due to such events will considerably increase during the next decades. Based on the activities performed it cannot be ruled out, however, that, depending on the specific site conditions, minor adaptations of the protection concepts may become necessary.

Article 17: Future activities

The German nuclear power plants were designed taking into account protective measures against external hazards (→ Article 17 (1)). Generally, this design was made on a deterministic basis. The protection against external hazards always has to be proved anew within the scope of the safety reviews (SRs) (→ Article 14 (1)). A new hazard analysis is not necessarily prepared, however. In view of the new findings on external hazards, it seems advisable to compare the events currently to be postulated with the design of German nuclear power plants. Such a review of the assumptions concerning the events to be postulated is to be examined within the scope of a research project for several selected events first (earthquake, extreme water levels, wind loads, icing and impacts from dangerous materials).

Further developments are also considered with regard to the probabilistic assessment of the protection of nuclear power plants against external hazards within the scope of the safety reviews (SRs) (→ Article 14 (i)): As the requirement to carry out probabilistic analyses for external hazards was included in PSA guideline [3-74.1] as recently as 2005, the corresponding subordinate documents [4-7] are not fully developed yet.

Based on initial experiences with the implementation of the methods for probabilistic safety analyses of nuclear power plants (“PSA methods” [4-7]) and additional theoretical considerations, the corresponding chapters are to be revised in the next years.

18 Design and construction

ARTICLE 18 DESIGN AND CONSTRUCTION

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

i) the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defense in depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur;

ii) the technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis;

iii) the design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface.

18 (i) Implementation of the defence in depth concept

Overview of the legal and regulatory requirements for the design and construction of nuclear installations

The Atomic Energy Act [1A-3] elevates the protection against damages as required according to the state of the art in science and technology to a major criterion for granting of a licence (→ Article 7). For this damage precaution, a concept of safety provisions becoming effective successively reflects today's state of the art in science and technology. This is referred to as defence in depth concept. The basic features of the concept are specified by the provisions of the nuclear rules and regulations (→ Article 7 (2) (i)). The Safety Criteria [3-1] with its supplementing interpretations [3-49] cover the design for normal operation, abnormal occurrences and the control of design basis accidents.

At the first level of defence, the defence in depth concept places high demands on the design and quality of the technical systems and equipment as well as on personnel qualification in order to ensure a plant operation as failure-free and environmentally compatible as possible. At the second level of defence, the concept includes measures for the control of abnormal occurrences and for the prevention of design basis accidents. The third level of defence comprises technical systems and measures for the control of design basis accidents. For these, the German rules require high reliability.

Section 49 of the Radiation Protection Ordinance [1A-8] defines specific planning values to which the release of radioactive material in case of design basis accidents has to be limited.

The design basis accidents considered in the design of the last licensed nuclear power plants are specified in the accident guidelines [3-33].

The nuclear rules and regulations also define requirements for precautions against events beyond the original design basis accidents (beyond design basis accidents of level of defence 4a to 4c). These are, among others,

– very rare events (e.g. ATWS, emergency situations such as accidental crash of a military aircraft, gas cloud explosion),
– events with multiple failure of safety systems and equipment (e.g. station blackout), as well as
– accidents with core damages.

The contents of levels of defence 4b and 4c are specified in the RSK guidelines for pressurised water reactors [4-1] and supplement by further RSK recommendations. For such events, damage preventing (preventive) and damage mitigating (mitigative) measures were provided. An overview of major backfitting measures is given in Table 18-1.

Moreover, the Safety Criteria [3-1] stipulate that organisational and technical measures inside and outside the nuclear installation are to be provided by way of precaution to identify and mitigate the consequences of accidents.

Current status of implementation of the provisions of the defence in depth concept, in particular regarding the integrity of the fuel, the reactor coolant pressure boundary and the containment system

The concept for prevention and control of design basis accidents is implemented at all German nuclear power plants. The main requirements of the safety criteria were already considered in the design of the first construction lines. In the early eighties, the RSK guidelines were revised and, above all, new requirements for the separation of redundancies were included. These requirements could be considered in the design of the nuclear installations that were in the planning phase at that time. At the already existing nuclear installations, backfitting measures, some of them extensive, were performed to achieve this safety standard there (→ Table 18-1).

<u>Implementation of the fundamental safety principles</u>

Pursuant to the German rules and regulations, the principles “safety-oriented measures”, “automation”, “functional separation”, “redundancy” and “diversity” in all German nuclear power plants have been implemented as far as technically possible and reasonable. The former applies in particular to the actuation of reactor protection system. In the first phase of an accident, manual actions to control the accident are not required but possible. Redundant safety systems are arranged in a spatially separate way and are independent from each other, i.e. there are no connections between the redundancies that could result in negative interactions. The separation of redundancies is not only realised in the area of process engineering, but also in the area of instrumentation and control. Due to the physical or spatial separation of safety-relevant components, an influence of neighbouring redundancies, e.g. in case of system-immanent failures (jet forces), flood, fire or in case of external events, are precluded. If this principle is not universally realised in older plants and cannot be achieved through backfitting measures, compensatory measures are in place. At the component level, the diversity principle is realised, above all, in those areas where the potential for systematic failures is great and highly safety-relevant.

<u>Measures for the control of beyond design basis events and for the minimisation of the radiological consequences</u>

In addition to the multi-level concept for the prevention and control of design basis accidents, measures were provided at an early stage, following international developments, to prevent core melt also in case of beyond design basis scenarios or to mitigate the radiological consequences of a core meltdown. For this reason, work has been increasingly performed since the early 1980s to assess plant behaviour in situation where safety systems and equipment do not function as designed and to develop measures to mitigate the consequences of such event sequences.

Under consideration of these objectives, measures to reduce the probability of occurrence of severe accidents (preventive accident management measures) or measures to mitigate the consequences of severe accidents with core damage (mitigative accident management measures) have been included in the design or performed as backfitting measures at existing German nuclear power plants since the 1980s (→ Table 18-1). Preventive accident management measures concern, in particular, measures by which heat removal from the core can be restored at a state before developing into a large core damage.

With these and other measures within the framework of the defence in depth concept, it was possible to counteract the newly identified risks which did not have to be considered at the time of the safety assessment in the course of the licensing process.

Overview of major backfitting measures since commissioning performed due to deterministic and probabilistic assessments

Since the commissioning of the nuclear power plants, safety improvements have been continuously carried out there. As a result, the plants were adjusted to the state of the art in science and technology. Chapter 14 describes some backfitting measures in detail that, in particular, strengthen the defence in depth concept. At the different levels of defence, the main backfitting measures are as follows:

Table 18-1 Major backfitting measures in nuclear power plants according to construction line

	Objective of improvement	PWR construction line				BWR constr. line	
	Improvement measures	1	2	3	4	69	72
1.	**Enhanced reliability of specified normal operation**						
	Additional off-site power supplies	X	X	●	●	X	●
2.	**Enhanced effectiveness and reliability of safety systems and equipment**						
	Additional emergency diesel generators	X	●	●	●	X	X
	Additional high-pressure and low-pressure emergency core cooling systems (PWR)	X	●	●	●		
	Extension of emergency core cooling systems/ additional injection lines (PWR)	X	X	●	●		
	Technical improvement of the high-pressure/low-pressure interfaces	X	X	X	X	X	X
	Independent emergency core cooling systems/new diversified emergency core cooling system (BWR)					X	X
	Additional emergency feedwater systems	X	X	●	●	●	●
	Technical improvement of components important to safety to withstand design basis accidents	X	X	●	●	X	●
	Additional valves for containment isolation (BWR)					X	●
	Diversified pilot valves for safety and pressure relief valves (BWR)					X	●
	Diversified pressure relief valves (BWR)					X	X
3.	**Improvement of safety during specific emergency situations**						
	Emergency systems	X	X	●	●	X	●
4.	**Mitigation of fire consequences**						
	Physical separation by installing new systems in separate buildings	X	●	●	●	X	●
	Additional fire fighting systems	X	●	●	●	●	●
	Backfitting of fire fighting systems	X	●	●	●	●	●
	Technical improvement of fire dampers and fire partitions	X	X	●	●	●	●
	Additional fire dampers	X	●	●	●	X	●
5.	**Improvement of barriers**						
	New pipes of improved material for main steam, feedwater and nuclear auxiliary systems (BWR)					X	●
	Optimised materials for steam generators (PWR)	X	●	●	●		
	Removal of the former pressurised bearing water system with its connections outside of the containment (BWR)					X	●
6.	**Accident management**						
	Improvement of technical equipment for damage prevention - Containment inertisation (BWR) - Control of Station Blackout (battery supported control of the high pressure injection system)	X	X	X	X	X	X
	Improvement of technical equipment for damage mitigation - Filtered containment venting - Sampling system in the containment	X	X	X	X	X	X

X improvement through backfitting ● already covered by the design

Level of defence 1:

The principles of basic safety (→ Article 18 (iii)) were immediately applied at the newer nuclear power plants. At the plants of older construction lines, post-qualifications were made either to verify the compliance with these principles or for the assessment of identified non-compliances. In several cases, the assessments showed a need for extended safety demonstrations and measures to be implemented.

Level of defence 2:

At the second level of defence, particular importance is attached to the limitation systems that precede the protection system. There are three types of limitation systems that are classified according to task and requirement. Operational limitations are I&C systems with increased reliability which, for the rest, are to be comparable with the control systems. In case of operational occurrences, the limitations shall automatically limit the process variables to defined values in order to increase the availability of the plant (operational limitations), limit the process variables to defined values in order to maintain initial conditions for the accidents to be considered (limitations of process variables) and bring safety variable back to values at which continuation of specified normal operation is permissible (protective limitations).

The aim is to reach a high degree of automation for relief of man from short-term measures and comprehensive preventive measures to counteract development of abnormal occurrences into accidents and a high tolerance against human failures. The requirements for comprehensive, reliable and user friendly process information systems also provide technical support for personnel actions. The aim of these extensions of technology is to enable man to fulfil his safety task within the overall system in an optimal manner.

Level of defence 3:

At the third level of defence, improvements were carried out for the control of design basis accidents. Here, for example, the optimised measures in case of steam generator tube rupture are to be mentioned. Furthermore, extensive upgrading took place for earthquake design.

Level of defence 4a:

At this level of defence, improvements were carried out for the control of ATWS events. At plants of older construction lines, extensive backfitting measures were performed for the control of emergency situations, such as aircraft crash.

Level of defence 4b and 4c:

The preventive measures of accident management are to prevent severe core damages. The main objective is the maintenance or restoration of core cooling and transfer of the plant into a safety state.

In case of core damages, the measures for damage minimisation are to mitigate severe radiological impacts in the plant and environment; here, the main objective is the maintenance of the activity-confining barriers still available and the assurance of a controlled state in the long term for the protection of the environment.

In German nuclear power plants, appropriate measures are planned or have been implemented in the form of backfitting measures:

- Ensuring core cooling and integrity of the RPV in BWR installations (e.g. independent injection system, diverse pressure control systems, additional opportunity for initial and successive injections into the RPV), provisions for secondary and primary side bleed and feed in PWR installations (upgrading of safety valves and relief valves at the pressuriser that can blow down water, steam and water-steam mixtures),
- ensuring integrity of the containment and activity confinement for PWR and BWR installations (e.g. secured containment isolation, filtered containment venting, limiting of the hydrogen concentration in the containment by using catalytic recombiners in PWRs or inertisation with nitrogen in BWRs, sampling system for the containment),
- ensuring emergency power supply for PWR and BWR installations (e.g. connection with the neighbouring unit, increasing battery capacity, additional power supply by means of underground cables).

Improvements going beyond the individual levels of defence

These measures include, for example fire protection and the separation of redundancies, improvements and extensions to the operating and accident management manuals and the simulator training.

The improvements regarding the area of man-technology-organisation also go beyond the individual levels of defence. At the end of the 1970s, the development of concepts was started, going beyond the ergonomic design of work systems and equipment, for optimisation of an integrated design of the socio-technical overall system man-technology-organisation (MTO) for a reliable and appropriate plant design and the power plant process. The governing principles of this concept are as follows:

- The optimum design of the overall system shall be the objective, not the adaptation of the social to the technical system or vice versa.
- The sharing of functions between man and technology shall be realised under consideration of the human capabilities and limitations.
- Man shall be effectively supported in his indispensable role in the fulfilment of safety-related tasks and relieve him from tasks conflicting with safety objectives.
- Human actions must be protected to the larges possible extent by a system behaviour resistant against human failure.

The concept led, in particular, to requirements for the improvement of technical support of the personnel and the organisational support of man in fulfilling his safety tasks. This concerns, in particular, the protection goal oriented procedure in case of design basis accidents and beyond design basis accidents (→ Article 19 (iv)).

At the newer nuclear power plants, these requirements were directly and completely implemented. For plants of older construction lines, the organisational improvements were implemented. Moreover, a number of technical retrofit measures were performed within the framework of the respective plant concept.

Since the late 1990s, the development of the requirements on a comprehensive safety management system (SMS) has been of importance for further optimisation of the integrated structuring of the socio-technical overall system MTO. The task of the safety management system is to ensure the continuous and systematic control and improvement of the reliability of the complex MTO system of the nuclear power plant (→ Article 10 and Article 12).

Improvements in systems engineering carried out since the last report due to deterministic and probabilistic assessments

In Germany, the improvements in systems engineering are characterised by three stages: 1) upgrading older construction lines to approach the state of the art in modern construction lines, 2) backfitting measures at level of defence 4, and 3) the implementation of technological progress as continuous task.

The first two stages have been extensively concluded. In the last years, improvements were focused on modernisation measures, the implementation of technological progress to further enhance precautionary measures against damage and the feedback due to GRS information notices and operating experiences.

These improvements comprise numerous individual measures; some examples will be highlighted in the following:

- The insulating material and, partially, the insulation cassette systems were exchanged within the scope of the sump issue. In all PWRs concerned, the sump strainers were upgraded to smaller mesh sizes and equipment for backflushing was implemented including the appropriate procedures.
- The fire protection precautions, fire warning systems and ventilation systems were upgraded.
- In several plants, the plant-internal flood protection was further optimised.
- With regard to aspects of system reliability, the power supply of individual components was optimised, e.g. by extending the emergency power supply. In addition, the response levels of motor protection relays of safety-relevant systems were adjusted.
- In all plants, the instrumentation and control was further optimised and improved. The measures taken comprise, for example, changes of interlocking mechanisms, optimisation of the threshold values and backfitting of the process computers as well as the segregation of controls to enhance reliability of the emergency power supply.

In terms of plant-specific improvements, upgrades are implemented that, as a result of periodic safety reviews, turned out to be expedient to further enhance the safety level of the plants.

Regulatory reviews and monitoring

Design and construction of a nuclear power plant follow the nuclear rules and regulations. These and the licensing process are described in Article 7 (→ Article 7 (2) (i), (2) (ii) and (2) (iii)).

In the licensing procedure it is verified, for example, that the releases of radioactive material determined for all design basis accidents (events of level of defence 3) under conservative boundary conditions are below the planning values of Section 49 of the Radiation Protection Ordinance. In this range, the internationally accepted design principles, such as redundancy, single failure criterion, physical separation, are considered.

The procedures applied to backfitting measures or safety-relevant modifications to the plant are the same as those applied to the erection of a plant (→ Article 7(2) ii)). In case of the former, however, a graded approach is applied that depends on the safety relevance of the backfitting measure. In this context, it makes sense to describe the basic procedure when carrying out modification or backfitting measures. Depending on the authority and the *Land*, the procedures specified by the regulatory authorities for modification or backfitting measures vary in details, but are basically the same for all installations. A distinction is made between modifications that are subject to a formalised modification procedure and modifications that are not subject to this procedure. The former include safety-relevant modifications to systems, components, buildings and operating procedures. Not subject to the modification procedure is, for example, the procurement of parts, editing of documentations or modifications to non-qualified components. To keep the administrative effort within a limit, the modifications are divided into several categories, with the allocation of a modification to a certain category depending on the safety-relevance of this modification. Modifications of the highest category require a licence by the competent nuclear regulatory authority. Modifications of the lowest category may be carried out by the operators on their own responsibility. The highest category includes modifications which result in an increasing activity inventory in the plant; the lowest category includes e.g. modifications that do not affect the safety level of the plant. Technical modifications and modifications of operational specifications, e.g. organisational modifications are subject to the modification procedure. Depending on the modification measure, other authorities such as building authorities, trade supervision or environmental protection agencies are also involved in the licensing procedure.

One example of a modification of the highest category is the increase of reactor power. Such a modification concerns many areas of a plant as the activity inventory in the reactor core increases, the neutron fluence at the reactor pressure vessel increases, the residual heat to be removed is higher and many transients and accidents run faster when reactor power is increased. Basically, the safety margins are partially consumed when reactor power is increased. The authorised expert therefore has to verify if the nuclear regulations are still complied with. All reassessments have to be carried out in accordance with the state of the art in science and technology. Therefore, to some extent new extensive calculations with new verification methods have to be conducted. Probabilistic assessments have not been carried out in this context so far. In addition to the impacts on systems, specific impacts on components have to be assessed. The increase of reactor power does not only result in technical modifications but also in modifications to the operating documentation. These modifications are – as far as they are safety specifications – also subject to assessment. In case of an increase of the thermal power of a nuclear reactor, the Federal Minister for the Environment has reserved the right to approve.

Expediency and effectiveness of all systems and measures originally available or backfitted is continuously checked by means of the operating experience gained (→ Article 14 (ii) and Article 19 (vii)) and the integrated event analysis including MTO (→ Article 12)) also with regard to further optimisation possibilities. Another regulatory control takes place within the framework of the periodic safety review (→ Article 14 (i)).

18 (ii) Qualification and proof of incorporated technologies

Legal and regulatory requirements for the use of technologies proven in operation or sufficiently tested

The RSK guidelines for pressurised water reactors (PWRs) [4-1] require the use of qualified materials proven in operation or sufficiently tested systems.

A quality assurance system according to safety standard [KTA 1401] ensures that the requirements are fulfilled and maintained until decommissioning. The KTA safety standards contain further extensive requirements regarding qualification and proof of incorporated technologies and the reliability of safety-relevant structures, systems and components. The requirements are classified according to the principles of the defence in depth concept and their safety relevance of the system. Details regarding the technical realisation are specified in the regulations and guidelines. The corresponding KTA safety standards are listed in Appendix 5, in particular the series 1400, 3200, 3400, 3500, 3700 and 3900. In these standards, reference is also made to the proven operating experience. Special requirements and, where appropriate, verifications by experiments for individual systems and components are also derived from safety analyses.

Measures for the introduction of proven technologies

<u>Materials and construction</u>

General requirements apply to the qualification of the materials used according to the conventional and nuclear rules and regulations. The qualification tests closely follow the practice from engineering experience with industrial installations requiring regulatory supervision and from construction regulations. In the case of nuclear power plants, both type and extent of the required certification are expanded, compared to the conventional requirements, in accordance with the safety relevance of the components.

With respect to the structural design of pipes, vessels and supporting structures, there are requirements with respect to stress and strain and to ease of inspection. As far as nuclear influences are expected, e.g. by radiation, this is accounted for in the corresponding requirements regarding materials and qualification certifications.

The influence of identified quality reducing factors on the safety margins regarding the manufacturing of components was examined, and proof has been delivered that the requirements contained in the standards ensure sufficient margins.

The detailed requirements for a qualification proof of the manufacturing process used are specified in safety standards. Different standards apply, depending on the materials, product forms, or the scope of application, e.g. pressure retaining boundary, secondary systems, containment and lifting equipment. The qualification proof of a manufacturing process is carried out for each manufacturer individually and is repeated at specified time intervals. An independent authorised expert will participate in manufacturing steps that are important with respect to the qualification of the materials, the manufacturing process and the components. The results of the tests are documented and the evaluations of the authorised experts are submitted to the licensing authority.

Active components

For the majority of active components and their operating hardware, the plant manufacturers and operators make use of series-produced items for which extensive industrial experience is available. This applies in particular to the electrical components and to the instrumentation and control equipment, such as electric motors, controller drives, switch gears, electronic measuring instruments, data processing equipment and cables. However, components used in mechanical engineering may also be series-produced items. Typical examples are the valves and pumps, as far as they do not belong to the pressure-retaining boundary, but, e.g., those used in cooling water and auxiliary systems and within the range of the turbine. Such equipment is deployed in conventional power producing facilities and in the chemical industry. The same applies to the consumable operating media, like oils, lubricants, fuels, gases and chemicals, e.g. for water conditioning.

Type and extent of the qualification proof are specified both in nuclear and in conventional standards in accordance with the individual safety significance. Wherever specific nuclear influences are expected, e.g. by the ambient conditions, the qualification is shown with supplementary, in many cases experimental proofs. This applies, for example, to the failure resistance.

In those particular cases where no industrial experience is available for individual components, the qualification of the technology involved is verified in extensive series of tests.

Extensive cold and warm test runs are performed during plant commissioning in order to verify the proper functioning of the systems, the interaction of components and the effectiveness of the safety equipment (→ Article 19 (i)).

Analyses, tests and experimental methods for the qualification of new technologies, such as digital I&C

The qualification is carried out in accordance with the nuclear rules and regulations. In this respect, safety standards [KTA 3503 to KTA 3507, KTA 3706] are to be mentioned particularly.

The qualification of the installed techniques is proven in various ways. These are

- practical experience with long-term use under comparable operating conditions,
- experimental investigations on the behaviour of the materials and components used under operating and accident conditions,
- proof on the basis of verified models,
- reliability data or service life certificates in the case of the components of the I&C equipment, and
- critical load analyses.

The feedback of experience from manufacturing and operation are of great significance to the evaluation of qualification proof of the installed techniques (→ Articles 19 (vi) and (vii)).

Experience feedback has shown in particular cases that the suitability of certain technical equipment was to be regarded as insufficient for long-term operation or that there were justified doubts for it. It is part of the safety culture in Germany, and has proven very effective, that all parties involved look for a technical solution in consensus together that would not only solve the immediate safety problem but would also bring about long-term improvements. Typical examples for such cases are the replacement of pipes in the main steam and feed-water systems of boiling water reactors both inside and outside of the containment, or the backfitting of diverse pilot valves in the overpressure protection system of boiling water reactors. Other examples are the conversion of all pressurised water reactors to a high all volatile treatment (high-AVT) of the secondary-loop water chemistry, or the fabrication of weld seams for better testability with ultrasonic procedures either by machining the weld surfaces or by re-welding the seams on components and pipes in pressurised and boiling water reactors. Furthermore, the instrumentation needed for a more exact determination of local loads, e.g. due to thermal stratifications and cyclic stresses, was increased in all nuclear installations. The results from these measurements are used both for optimising operating procedures as well as in ageing assessments for a more reliable determination of the utilisation factor of components.

Electrical and I&C components are qualified, in particular, to safety standard [KTA 3706]. In some cases, international rules and regulations are also referred to. The requirements on the digital I&C for the control of design basis accidents are currently under discussion. This applies, in particular, to the question of redundancy and diversity.

According to the criteria of the RSK guidelines [4-1] for PWRs “Electrical Equipment of the Safety System and the Other Safety-related Systems“ and “Incident Instrumentation” as of 01.97 the applicability of the analysis tools for safety-related proofs is also to be confirmed. This may be done by means of exact analytical solutions or other validated analysis methods.

Regulatory reviews and monitoring

The test programmes are submitted to the licensing and supervisory authority and are checked by the authorised expert consulted. The authorised expert, furthermore, participates in the tests. With regard to questions important to safety, the authorised expert performs additional controlling calculations preferably with independent analytical models.

The authorised expert reviews all aspects subject to the licensing and supervisory procedure with regard as to whether additional requirements are necessary beyond those specified in applicable standards and guidelines.

18 (iii) Design for reliable, stable and easily manageable plant operation

Overview of the regulatory bases for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface

The general requirements with regard to the design of nuclear power plants, to simplicity of system design, physical separation of redundant subsystems, as well as to accessibility for inspections, maintenance and repairs are specified in the Safety Criteria for Nuclear Power Plants [3-1].

High reliability of systems and components is already to be achieved during design, construction and manufacturing by adherence to the design principles. This includes high-quality materials and comprehensive quality assurance. In combination with an optimal maintenance concept, a high reliability and availability of systems and components is to be achieved for the entire lifetime of the plant. Thus, an appropriate design and quality of the components of the first level of defence ensure a reliable and undisturbed operation.

The Safety Criteria for Nuclear Power Plants [3-1] include requirements for the design of workplaces and work procedures under consideration of ergonomic aspects. These are to be designed in such a way that they create the prerequisites for the personnel's optimal behaviour in terms of safety during undisturbed operation and also during abnormal operation and design basis accidents. Detailed requirements both with regard to technical measures and to the administrative procedures of work tasks are specified, among others, in the KTA safety standards series 1200 and 3200.

Ergonomic design of control stations

Concrete specifications on the ergonomic-technical design of control room, emergency control room and local control stations are laid down in safety standard [KTA 3904]. These also include requirements for the functional and spatial arrangement, personnel staffing, the design of works systems and equipment and environmental influences with specifications on lighting, air conditioning and acoustics. Concrete requirements for analogue and digital displays of position, size, arrangement etc. of units, scale graduation marks, numbering etc. are also described precisely. In some cases, reference is made to German DIN standards for further details. These also include the procedure for the implementation of ergonomic modifications. A change in the state of knowledge is taken into consideration where necessary.

The procedure covers the following steps:

- Description of the tasks of new components,
- description of the tasks of the operating personnel,
- check of task performance within the construction and testing phase, and
- analysis and assessment of different concepts with regard to their ergonomic suitability.

In this respect, requirements for analysis and assessment methods applied are also made. As a tool for the support of ergonomic studies for the purpose of the items mentioned, the database system EKIDES (Ergonomics Knowledge and Intelligent Design System) was developed and implemented by the plant operators.

Personnel qualification

In addition to technical measures, human and organisational measures and their interactions are also of great importance. Therefore, the Atomic Energy Act and the other legal regulations and non-mandatory guidance instruments mentioned provide that for licensing the fulfilment of requirements regarding reliability, the requisite qualification and knowledge of the groups of persons defined there is equally necessary as the fulfilment of the requirements regarding damage precaution by construction and operation of the plants. These requirements must be seen comprehensively and also extend to the economic reliability and appropriateness of the organisation (→ Article 9).

Integrity concept

In the late 1970s, the concept of basic safety was developed. It comprises detailed provisions with the special objective of preventing catastrophic failure of pressure retaining components due to manufacturing defects. This concept is based on the Safety Criteria [3-1] on damage precaution and the RSK guidelines [4-1] including the general specification of basic safety and has been further developed in the last 25 years. The basic safety of a plant component is characterised by the following principles:

- high-quality materials, especially with respect to fracture toughness,
- conservative stress limits,
- avoidance of peak stresses by optimisation of the design,
- application of optimised fabrication and test technologies,
- awareness of any possible fault conditions and their evaluation, and
- accounting for the operating medium.

More detailed guidelines for the implementation of the concept were included in the relevant KTA safety standards.

For continuous assurance of component integrity during operation of light water reactors, in Germany, the concept of basic safety was further developed to the integrity concept. Recent developments in this area incorporate, in particular, ageing processes and their control in the overall concept. It puts all aspects of integrity demonstration into predefined interrelations (→ Appendix 4). The main process elements of the consistent German proof of integrity have been incorporated in safety standard [KTA 3201.4] in form of a process diagram.

Of particular relevance is the proof of integrity for piping systems with break preclusion. The operating experience with these pipes in German nuclear power plants is positive in every respect. For these systems, no indication changes or even service-induced cracks were detected by in-service inspections. Until now, the integrity concept has been proven in practice and presents an important contribution in terms of damage precaution.

Measures introduced by the plant operators and technical improvements

An example of measures and technical improvements in plants of older construction lines are the limitation systems.

In their original design, German plants were equipped with a comprehensive automatic limitation system the objective of which is, among other things, to early detect small deviations from the operating conditions and to automatically correct them, if required. This limitation system is also used to allow for optimised operating modes which, considering the aspects remaining lifetime and ageing management, optimises the stress on the components. From this point of view, there have been no basic changes in recent years.

Based on the findings from operational management, the limitation systems and their operating modes are continuously optimised. In plants of older construction lines, some new limitation system functions have been installed. In some plants, the originally analogue I&C of the limitation system is being upgraded to the I&C system Teleperm XS.

In addition, an optimised concept for ageing management and partly premature exchange of the generator transformers has been implemented in all plants.

Monitoring and control by the supervisory authorities

Prior to performance, the plant operator has to submit safety-relevant modifications of the nuclear power plant or its operation to the nuclear authority for licensing or approval within the supervisory procedure (cf. 18 (i)). The regulatory review is usually performed with consultation of authorised experts. It is checked whether the requirements of the rules and regulations are fulfilled. The review also includes the consideration of findings from operating experience as well as the consideration of human factors and the man-machine interface.

Article 18: Progress and changes since 2007

See details under Article 18 (i).

Article 18: Future activities

The general duties of the plant operators and the competent authorities according to the regulatory requirements in terms of a continuously improving safety culture and in terms of the requirements of the Convention are a guide for action and measures. In particular, the plants are continuously adjusted to new requirements of the rules and regulations, i.e. the KTA safety standards, and to the state of the art in science and technology in accordance with the RSK recommendations. Another important issue is the constantly gained operating experience in Germany and abroad that is implemented - where possible and appropriate – and leads to plant improvements.

19 Operation

ARTICLE 19 OPERATION

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

i) the initial authorization to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme demonstrating that the installation, as constructed, is consistent with design and safety requirements;

ii) operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation;

iii) operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;

iv) procedures are established for responding to anticipated operational occurrences and to accidents;

v) necessary engineering and technical support in all safety-related fields is available throughout the lifetime of a nuclear installation;

vi) incidents significant to safety are reported in a timely manner by the holder of the relevant licence to the regulatory body;

vii) programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organizations and regulatory bodies;

viii) the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal.

19 (i) Initial authorisation

Legal and regulatory requirements

According to Section 7 of the Atomic Energy Act [1A-3], a licence is required for the construction, operation or any other holding of a stationary installation for the production, treatment, processing or fission of nuclear fuel, or for essentially modifying such installation or its operation (→ Article 7).

The following description explains the approach for construction and commissioning of the existing nuclear power plants. According to the Atomic Energy Act, this approach is also valid for modifications of the existing plants and their operation requiring a licence permit (→ Article 7 and 18). In Germany, licences for new nuclear power according to Section 7 para 1 of the Atomic Energy Act will no longer be granted.

The licences according to Section 7 of the Atomic Energy Act were granted for the construction and operation of nuclear power plants stepwise with partial licences for construction and operation.

Prior to each partial licence, the respective licensing prerequisites were to be examined. The information required for the examination specify the statements of the safety analysis report

(→ Article 14 (i)) and are contained in the regulatory guidelines [3-7.1] and [3-7.2]. The regulations on the responsibility of the licensee during construction and commissioning are presented in detail in Article 9 (→ Article 9).

The following sections describe the requirements considered in the decisions whether to grant permission for the start of operation of a nuclear power plant.

Safety analysis

The granting of permits for the initial operation of the existing nuclear power plant was based on the results of a safety assessment and its detailed review by the competent authorities (→ Article 14 (i)), on accompanying inspections during construction and on the results of a comprehensive commissioning programme, subject to licensing by the competent authority. Special emphasis was put on verifying that all applicable safety requirements specified in the nuclear safety regulations are fulfilled at the time the permit for initial operation is granted. It was generally checked whether the nuclear installation in its as-built condition met all applicable design and safety requirements. For these reviews, the competent authorities were authorised to consult experts (→ Article 19 (v)).

Commissioning programme

The tests and inspections carried out within the commissioning programme certified that the individual components and systems and the plant as a whole were as planned and designed and were in safe, functioning order. In general, the commissioning was carried out in four steps:

– Commissioning of the systems,
– hot functional test, Phase 1,
– hot functional test, Phase 2, and
– zero-load and power tests.

In the pre-operational tests (commissioning of the systems), all necessary functional and operational tests were performed to ensure that the individual components and systems were in proper functioning order. In the hot functional run, Phase 1, the reactor coolant system was operated for the first time together with the reactor auxiliary and other systems to ensure proper functioning of the plant as a whole, as far as this was possible without fuel loading and nuclear steam generation. Hot functional run, Phase 2 was performed after initial fuel loading of the reactor. It covered those commissioning activities which were not feasible or not appropriate to perform before the core was loaded. Its objective is to verify the functionality and the safety of the plant as a whole before starting nuclear operation. The final step of commissioning began after first reaching of criticality and covered comprehensive tests at zero- and partial-load levels. The levels were chosen to be most suitable for the technical or physical verification of satisfactory functioning.

The whole commissioning process was reviewed by authorised experts called in on behalf of the supervisory authority. The authorised experts partly participated in specific tests. The approval of the different load levels was given by the supervisory authority in the final step of commissioning (zero-load and power tests).

Accompanying control during construction

In parallel to construction and the commissioning programme, accompanying controls were carried out extending to the manufacturing and installation of safety relevant equipment. By means of the accompanying control, the plant operator as well as the authority examined whether the actual design of the systems and components important to safety met the requirements specified within the framework of examination. The accompanying control was subdivided, depending on the item, into the design review, materials testing, construction and assembly tests, pressure tests, and acceptance and functional tests. The test results were recorded and documented in reports, attestations and certificates:

- The design review was an evaluation performed on the basis of plans and technical drawings. It focused on the design, dimensioning, materials used, the manufacturing and assembling procedures, the ease of inspection, accessibility for maintenance and repair, and on instrumentation and control.
- The material, construction and pressure tests were carried out to ascertain that the actual realisation for pressure retaining components and systems was in conformance with the approval documents.
- Overall, the test was conducted during the installed state of the component.
- The acceptance and functional tests ensured that the components and systems had been properly assembled and were in proper functioning order. For special components, they were performed on test stands, otherwise during commissioning.

Regulatory supervision

The scope of regulatory supervision in the construction and commissioning of nuclear reactors was defined on the basis of the above legal requirements.
Further information is given in Article 7.

19 (ii) Operational limits and conditions

Legal and regulatory requirements

Pursuant to the Nuclear Licensing Procedure Ordinance [1A-10] and the Guidelines Concerning the Requirements for Safety Specifications for Nuclear Power Plants [3-4], all the data relevant to the safety of the plant and its operation are to be submitted. The focal points are mentioned in [3-4] and followed up in safety standard [KTA 1201].

The safety specifications constitute a binding and updated documentation of the approved frame for the condition and mode of operation of the plant (operational limits and conditions for safe operation). Modifications concerning the safety specifications require the approval of the licensing or supervisory authority in charge.

The safety specifications are a constituent part of the operating manual and the testing manual.

Specification of limits and conditions

The operating manual (→ Article 19 (iii)) is the most important working document for the plant personnel. It contains all operating and safety-related instructions required for normal operation of the plant as specified and for the control of incidents as well as plant regulations applicable for all persons working at the plant. Structure and contents of the operating manual are described in the nuclear rules and regulations in safety standard [KTA 1201].

The safety specifications are included in the operating manual as separate chapter or as marked sections. Exceptions are those parts of the safety specifications that are not contained in the operating manual but in the testing manual.

Any modifications of the safety specifications require approval by the licensing or supervisory authority. The limits and conditions of safe operation in the safety specifications prescribed by the licensing authority must be met at any time.

In case of deviations from limits and conditions of the safe boundaries of operation, the measures to be taken are laid down in the operating manual (→ Article 19 (iii)). Irrespective of how fast restoration of normal operating conditions is performed, the result is documented and, if the respective criteria are met, is made part of the internal experience feedback as alarm notice (→ Article 19 (vii)).

Reviews and revision of operational limits and conditions, as required

In case of modifications of the safety specifications, the shift personnel concerned is directly informed about the new situation through meetings or notices. In addition, the simulator training (→ Article 11 (2)) regularly required for preservation of the technical qualification are used to practice new procedures in a targeted manner. If during operation it becomes obvious, e.g. due to special occurrences or more recent findings, that modifications to the safety specifications are necessary, these will be reviewed and changed accordingly.

In case of modifications of the plant or its operation, their impacts on the limits and conditions described in the safety specifications also have to be reviewed and changed where required.

Regulatory supervision

Due to the fact that modifications to the safety specifications are subject to regulatory approval, the competent licensing and supervisory authorities are always involved in the modification procedure. Should the competent authorities have indications that modifications to the safety specifications could be required, they may initiate reviews, also with the consultation of authorised experts, and enforce modifications, if necessary.

The nuclear supervisory authorities of the *Länder* monitor the compliance with the safety specifications by the plant operators through controls of plant records and review of the reporting by the plant operators according to the regulations specified in the licences.

19 (iii) Procedures for operation, maintenance, inspection and testing

Legal and regulatory requirements

In addition to technical prerequisites, the licence of a nuclear power plant is also based on personnel and organisational prerequisites (→ Article 9). The approved procedures for operation, including maintenance and testing, but also for the control of abnormal occurrences and accidents described in Article 19 (iv) determine the organisational and operational structure in the nuclear power plant. This structure is laid down in detail in the operating manual of the respective plant.

For the organisational structure, the following principles are of importance, among others:

- The plant manager is responsible for safe operation. In the event of his absence, this responsibility is transferred to his deputy or the shift supervisor on duty or to the person responsible for stand-by service.
- Instructions to the shift supervisor significant to the safety of the plant may only be given by the plant manager, the head of department for operation and the head of section for operation. However, these will only intervene with immediate operating procedures in well-founded exceptional cases.
- The tasks, authorisation and responsibilities of the managing personnel are clearly, without any overlap, and completely specified.
- To avoid any conflict of interests, the organisational units and persons responsible for quality assurance and for radiation protection are independent of the divisions responsible for operation and maintenance.
- The organisational structure is defined in the operating manual in the chapter “Personnel Organization”.

The organisational procedures required for a safe and licence-conform operation of the plant are laid down in the operating manual and the testing manual.

Operating manual/testing manual

<u>Operating manual</u>

All nuclear power plants have an operating manual. Structure and contents of the operating manual of a nuclear power plant are laid down in safety standard [KTA 1201]. The operating manual covers the plant regulations valid throughout the plant, as well as operational and safety-related instructions for different plant conditions, such as detailed instructions for the shift personnel with additional information regarding the different operating situations involved. Safety specifications (→ Article 19 (ii)) are explicitly marked as such in the operating manual.

The operating manual consists of the following parts:

- *Plant regulations*
  These comprise the personnel organisation (structural organisation with the right to issue instructions, tasks, responsibilities, subordination, etc.), the control room and shift regulation, maintenance regulation, radiation protection regulation, guard and access regulation, alarm regulation, fire protection regulation and first aid regulation. All plant regulations are part of the safety specifications.
- *Plant operation*
  This part contains the prerequisites and conditions for all operating phases of the plant as well as the safety system settings and conditions (part of the safety specifications → Article 19 (ii)), the criteria for the reporting of events to the supervisory authority and detailed instructions for normal and abnormal operation of the plant.
- *Design basis accidents*
  This part of the operating manual includes the design basis accidents with and without loss of coolant and accidents originating from external impacts and the related procedures to control these accidents during power and shutdown operation (part of the safety specifications → Article 19 (ii)).

- *Systems operation*
  This part covers the initial conditions for the different operating modes for all systems and the actions to be taken by the shift personnel as step programmes. In addition, it contains supplemental information, technical drawings and remarks.
- *Alarms*
  This is a complete listing by systems of all alarm signals from failures/malfunctions or dangerous conditions together with corresponding instructions on countermeasures and possible alternatives.

The operating manual is kept up to date through a revision service. The copy of the operating manual at the plant control room also contains all modifications in process.

Alarm plans and organisational structures for the control of possible emergencies are specified in the operating procedures but are not part of the operating manual.

Testing manual

The testing manual regulates the number and course of the in-service inspections on safety-significant plant systems and components to be performed by the plant operator. Structure and contents of the testing manual are laid down in safety standard [KTA 1202]. The testing manual comprises general instructions, the testing schedule and corresponding testing instructions for all in-service inspections.

The general instructions deal with the application and handling of the testing manual and the corresponding preconditions, e.g. the administrative procedures regarding test performance and result evaluation, permissible deviation from test intervals, participation of authorised experts in the test performance and in the case of modifications of the testing manual.

The testing schedule contains a list of all in-service inspections important to safety. It covers the test object, extent of test, test interval, required plant conditions under which the test is performed and a clear notation of the testing instruction. The testing schedule is part of the safety specifications.

The testing instructions identify the test object and the reason for performing the test (e.g. licensing requirement), the testing method, the target and the extent of the test. It also lists the supporting measures and documents, and describes the prerequisites, the performance (in case of functional tests e.g. switching sequence programme) and documentation of the test as well as the procedure for establishing a defined final condition after the test. In addition to a correct testing procedure, the testing instructions ensure that the limits of safe operation are also not exceeded during tests.

Availability of operating manual, testing manual and accident management manual

The operating manual, the testing manual and the accident management manual are directly available to the shift personnel at the control room. Other availabilities of and accessibilities to information, operating and communication equipment and facilities for the personnel are dealt with in Article 12.

Specification of the procedure for maintenance or modifications

The general procedures for maintenance measures and to some extent also in-service inspections and modifications are specified in the nuclear rules and regulations in the regulatory guideline on maintenance [3-41]. The term maintenance comprises preventive maintenance, inspection, servicing and repair. In particular, the regulatory guideline on maintenance specifies the work steps from planning of the measure, during its implementation up to the restoration of operational readiness and documentation. The procedure also regulates the safeguards to be taken. It ensures that a planned measure is assessed with regard to the actual plant conditions and aspects of plant safety, radiation protection [3-43.1] (→ Article 15) and personal protection which also go beyond merely nuclear issues (industrial safety, fire protection) are fully taken into consideration with appropriate timing. This also includes the isolation and normalisation of the system area concerned and the tests and inspections to be carried out. Within the operating procedures, the maintenance guideline is implemented in the maintenance regulation of the operating manual.

Since the construction of the nuclear power plants, the test and maintenance concepts have been developed against the background of operating experience and of findings from safety research. At the time of the construction of the plants (1969 to 1989), the classification of systems important to safety, components and other plant equipment as well as the specification of the scope and intervals of the tests were essentially based on straightforward engineering judgement. Technical drawings and documents were evaluated with respect to identifying those components required for the safety functions of the nuclear power plant. The concept of in-service inspections was, then, developed based on operating experience, on knowledge regarding component reliability and on recommendations by the component manufacturers. During implementation of this in-service inspection concept, a number of shortcomings caused by inaccessibility, technical restrictions, or an insufficient validity of the tests regarding activation of a component in case of demand were revealed, which have been overcome as far as technically feasible by appropriate modifications of the components, of the testing techniques, or of the testing procedures.

In recent years, probabilistic approaches have increasingly been used to supplement the engineering judgements.

In individual cases, the provisions based on operating experience were also checked and modified under probabilistic considerations (e.g. scope of the tests and test intervals for components of the reactor coolant pressure boundary specified in safety standard [KTA 3201.4]).

Involvement of the personnel

According to the plant operators, there is a very high degree of personal responsibility among the staff in the technical departments of German plants. Each technician/engineer is put in charge of a system or component and works on this responsibility mostly on their own responsibility and to a great extent independently.

To promote optimum work procedures and professional actions/performance, the personnel are additionally instructed correspondingly by so-called markers in the form of small index cards or pocket books, for example. These markers enhance professional action and thus a strong safety culture. Their implementation allows for a high level of safety and the availability of the installations. They define the expectations in terms of the staff’s professional performance.

The MARKERS are the bridge to transfer values, guidelines and objectives as well as internal and external processes and provisions into practical actions. They take into account international experiences that are reckoned good practice at IAEA and WANO and are laid down in their international guidelines.

Within the scope of a continuous improvement process, the personnel is furthermore called upon to attentively walk through the plant and report potential error sources, near events, actual events and, above all, faulty actions. Furthermore, there are different systems, for example on suggestions for improvement or continuous process monitoring, by which the processes and work procedures are continuously improved.

Faulty actions may even occur during the most professional work sequences and sources of error and weaknesses may arise even in the best systems. The crucial point is that a blame-free safety culture is created in which the staff can report such faults without having to worry that this may be detrimental or disadvantageous for them and that from these reports a feedback of experiences can be derived for the entire organisation.

Every report opens up the opportunity to make use of the employees' long-time experience and their daily findings to further enhance plant and occupational safety.

Integration of the work procedures into the management system

Generally, the work procedures in the nuclear power plants are supported by a so-called operating management system.

This system has a modular design and all persons involved have the required access to the system directly from their desktop computer.

The entire processing of work procedures during maintenance work as well as in case of modification projects is carried out by the technical departments and subsections involved in a transparent manner.

In addition, there is a networking with various extensive data bases, e.g. on plant-related data, documentation of maintenance activities and modifications to the plant or the parts and spares inventory that can be resorted to. That way the personnel are supported in their decision making through the provision of information in a practice-oriented manner as needed.

Furthermore, a process-oriented integrated management system has been or is currently being implemented in the German plants. This integrated management system comprises different individual partial management systems, e.g. on nuclear safety, quality assurance, environmental protection as well as on occupational health and safety.

The work procedures and processes that are recorded in the operational management systems are an integral part of the management system and are thus directly incorporated. Further details on the integrated management system are described in Article 13.

Regulatory supervision

All modifications to the operating manual, and in some *Länder* also modifications to the accident management manual, are subject to the supervisory or licensing procedure.

The supervisory authority and its authorised experts check within the framework of their on-site inspections (→ Article 7 (2) (iii) and Article 14 (ii)) whether the regulations for the organisational structure are also adhered to in practice. In addition to plant walkdowns and controls at the plant control room, controls of organisational processes are carried out, such as keeping of a shift log, performance of prescribed walk-throughs, the proceeding for the change of shift or the handling of alarms and work authorisations. Due to the close supervisory accompaniment of major processes at the plant (e.g. modification procedures, maintenance measures, investigations in response to reportable events), an insight can be gained into the personnel/organisational processes. In the area of radiation protection, e.g., compliance with dose limits and regulations on controlled areas and on the storage of radioactive material are controlled. Apart from that, safety-significant measured values for plant operation or emission of radioactive material are checked within the framework of on-site inspections.

At specified intervals, also defined in the testing schedule, authorised experts participate in the in-service inspections of the plant operator on behalf of the supervisory authority. The frequency of such participation depends on the safety significance of the respective inspection. The supervisory authority is informed about the results of the in-service inspections.

Modifications in the testing schedule or the testing instruction are reviewed by the supervisory authority by consultation of authorised experts.

An obligation to review maintenance strategies and measures through authority and experts is not generally laid down in the nuclear rules and regulations but in some cases stipulated in the licensing conditions.

Moreover, the supervisory authority defined procedures for regulatory review and inspection for those modifications which are not subject to formal licensing.

19 (iv) Procedures for responding to operational occurrences and accidents

Legal and regulatory requirements

Section 7 (2) of the Atomic Energy Act [1A-3] specifies that the grant of a licence requires that the operator take the precautionary measures against damages from the construction and operation of the installation that are required according to the state of the art in science and technology. Sections 49 to 51 of the Radiation Protection Ordinance [1A-8] contain graded radiological requirements for operation, design basis accidents, accidents and radiological emergencies (→ Article 7). The implementation in the form of corresponding plant-specific measures is carried out on the basis of KTA safety standards [KTA 1201, KTA 1203].

Abnormal occurrences, design basis accidents and emergencies

<u>Abnormal occurrences (abnormal operation)</u>

Although the operating condition “abnormal occurrences during specified normal operation” (abnormal operation) will cause operational restrictions (e.g. reduction of reactor power in case of a failure of one main coolant pump), there will be no safety reasons to discontinue plant operation. In the case of accidents, however, plant operation may be discontinued for safety reasons.

Design basis accidents

Detailed procedural instructions are specified for the shift personnel covering the individual operating modes for each of the abnormal occurrences or design basis accidents dealt with in the licensing procedure. These are contained in Part 2 and 3 of the operating manual.

The procedures for the control of design basis accidents have to be protection goal oriented. In addition, an event based approach may be chosen.

The procedures for control of design basis accidents are based on the following types of written instructions and aids:

- Accident sequence diagram,
- check of the protection goal criteria,
- accident decision tree,
- protection goal oriented handling of accidents,
- event-based handling of accidents.

In case of an event leading to a reactor scram, an accident sequence diagram is available which specifies the proceeding of the shift personnel. In some plants, there are additional criteria for initiating the accident sequence diagram (e.g. increase of the pressures inside of buildings without actuation of the reactor protection system). In a first step, the shift personnel should control the protection goal criteria to determine whether or not

- control of reactivity (subcriticality),
- cooling of fuel elements (coolant inventory, heat transport and heat sink), and
- confinement of radioactive material (in particular, integrity of the containment)

have been achieved, and thus the release of activity into the environment does not exceed the accident planning values. Should it be detected that plant parameters have a tendency to violate a protection goal criterion or a criterion is violated, then the respective protection goal oriented procedures are used to bring the plant parameters back into their normal range. If no violation of protection goal criteria is detected and the event may be assigned to a known type of accident, the further proceeding will be based on event-based procedures. If beyond design basis plant conditions are detected, the shift personnel will also consult the accident management manual with decision trees for severe accidents and will employ the accident management measures. The transition from design basis accident procedures to accident management measures is described in the section “protection goal oriented procedure” of the operating manual.

Irrespective of the procedure chosen to control a design basis accident, the protection goal criteria have to be reviewed cyclically, and the procedure has to be adapted if necessary.

Protection goal oriented procedures in case of design basis accidents

The protection goal oriented procedures do not require the identification of the actual event but are rather guided by the observable plant conditions (symptoms). The operating manual lists the corresponding plant parameters for each protection goal which have to be checked.

Each description of a protection goal oriented procedure is structured as follows:

- Definition,
- list of the important plant parameters,
- list of the important operating and limiting values,
- conditions under which the available measures are effective,
- description of the measures for ensuring that the protection criteria are met, and
- general remarks and pertinent diagrams.

If the protection goal criteria cannot be met, the accident management measures (→ Article 18 (i)), treated in the accident management manual, have to be applied according to additionally specified criteria.

Event-based procedures in case of design basis accidents

Event-based procedures are applied if none of the protection goals is endangered and if the event can clearly be assigned to an accident type (e.g. loss-of-coolant accident, failure of heat removal without loss of coolant, external impact). By means of detailed step programmes, the plant is brought into a long-term safe condition. In parallel, it is checked regularly whether the protection goal criteria are still met. Detecting that one of the criteria failed, the event-based procedures will immediately be interrupted to return to the protection goal oriented procedures in order to bring the respective plant parameters back into normal range.

Emergencies

For emergencies (beyond design basis accidents), the technical measures to be taken at the plant (→ Article 18 (i)), the accident management measures and auxiliary means required are contained in a separate document, the accident management manual [KTA 1203].

An emergency response team supported by personnel from the operating staff is part of the organisational prerequisites established in all nuclear power plants to control emergencies. The emergency response team should be able to start work within an hour. Suitable rooms, working appliances and means of communication are provided. In addition to the on-site emergency response team, another emergency response team is called in at the manufacturer’s of the plants (AREVA NP) whose task is to provide support on technical issues. A corresponding co-operation agreement exists with the Kerntechnische Hilfsdienst GmbH, a joint service set up by all operators of the German nuclear power plants to cope with emergencies and eliminate possible consequences. Alarm procedures and organisational structures are specified, depending on the respective plant, in the operating manual, accident management manual or emergency response manual. Further technical measures and accident management procedures are described in the accident management manual.

In addition to the main control room, German plants have an emergency control room for specific beyond design basis accidents. Staffing of the emergency control room, which is protected against external hazards, is necessary within up to 10 hours, depending on the event, due to the measures of the auxiliary emergency system taken place automatically in the initial phase of the event or the incident. The emergency control room may also be used additionally in case of specific operating conditions or design basis accidents.

Regulatory review

Due to the regulatory supervision of the nuclear power plants, in particular the handling of events is subject to the nuclear supervision. The so-called reportable events are one important group of events in nuclear power plants. These are events in nuclear power plants that fulfil the reporting criteria of the Nuclear Safety Officer and Reporting Ordinance (AtSMV). An event in a nuclear power plant is reportable if it meets the criteria specified in Appendix 1 of the Nuclear Safety Officer and Reporting Ordinance. According to this, the operators of nuclear power plants are obligated to report accidents, incidents and other events important to nuclear safety to the supervisory authority within specified time limits. The reportable events are assigned to the Categories S (immediate report), E (quick report) and N (normal report).

As soon as the supervisory authority receives the report, the authority makes an initial assessment of the reportable event with regard to potential consequences and impacts on the safety of the plant, the personnel and the environment. In doing so, it has to be assessed if there are any safety-related objections against the continued operation of the plant and if the report was submitted in due form and time and whether it is complete and correct as to its content.

The vast majority of the events are normal reports. The operator has to report them to the authority with reporting forms within 5 workdays after knowledge. The supervisory authority examines and assesses, with the assistance of authorised experts, each reportable event in respect of the causes, necessary corrective actions and improvement measures. The consulted authorised expert makes a written comment on this to the authority on short notice. The measures taken by the operator, the corrective actions taken and the precautions against a repeated occurrence are assessed. The measures and provisions made in the course of the further and complete processing of the reportable event are subject to supervisory monitoring.

19 (v) Engineering and technical support

Availability of engineering support

To clarify and assess complex technical matters and to perform technical inspections at the nuclear installations, the authority utilises inspection agencies and expert organisations experienced and recognised in the field of nuclear technology. These organisations have to meet strict requirements, both in respect of their expertise and with regard to sufficient staff capacities.

Furthermore, in case of events requiring immediate action, it is indispensible that the expert organisation is available and ready for action at any time. This availability is regulated by contract.

Internal technical support

In accordance with the organisational structure, as implemented at most of the German nuclear power plants, the production and operation division which is directly responsible for plant operation is supported in its activities by the organisational units, e.g. for technology, maintenance and surveillance.

These organisational units, whose integration into the organisational structure may differ from plant to plant, have well-defined tasks and keep the necessary technical expertise at their disposal for their fulfilment:

- Technology
  Maintenance and optimisation of the functionality and operational safety of the mechanical, electrical and I&C components and systems (specialised engineering knowledge of employed components and systems). This also includes the planning and surveillance of modification measures.
- Maintenance
  Planning, control, performance and surveillance of maintenance tasks and of technical modifications and backfitting measures.
- Surveillance
  Working out solutions for all technical problems that concern the nuclear installation or its operation, in physics, chemistry, radiation protection, environmental protection, fire protection and physical protection.

Apart from this, the plant operators have established own departments for dealing with general issues, in some cases also at the company's headquarters, in which staff from different disciplines work on generic projects.

External technical support

Regarding the implementation of modification measures, it is first checked which of the above mentioned units are to be involved in view of their competencies. An application for modification is jointly prepared and submitted to the authority. If extensive analyses are required for the obligatory verification of safety, the plant operators refer to the service of the manufacturers (AREVA NP and Westinghouse). The quality of the safety analyses (measured against the required protection against damage according to the state of the art in science and technology) is ensured by close co-operation of the manufacturers with numerous research institutes also across national borders. Usually, the plant operators award the contracts for manufacture and installation of components directly to the component manufacturers. The nuclear rules and regulations are such that only qualified manufacturers may be contracted which ensure the quality of their work by adequate quality assurance under their own responsibility (→ Appendix 2 ad [4-1]; General Specification of Basic Safety). From a safety and also economic point of view, the plant operators have a self-interest in the selection of manufacturers and suppliers and their quality assurance. In most cases, long-term contracts exist between plant operators and their suppliers. This way, planning reliability and thus maintenance of competence of the proven and qualified personnel of the suppliers are ensured. Maintenance and repair of the components are mostly included in the suppliers' service. In order to avoid scheduling conflicts for the highly specialised companies, the plant operators co-ordinate their time schedules for the major maintenance activities and plant outages on a nation-wide scale.

The plant operators are responsible for the documentation of plant-specific data (e.g. operating data, plant data, construction data). The corresponding licensing documents (operating, testing and quality assurance manuals) are updated by own staff.

Regulatory supervision

For their engineering and technical support, the authorities consult expert organisations (Section 20 of the Atomic Energy Act). In addition, the Reactor Safety Commission acts as an advisor to the BMU in respect of the safety of nuclear installations. Research has to be considered as another supporting factor.

The grown German nuclear supervisory system with its distribution of tasks among the Federation and the *Länder* is also defined by the inspection frequency by the consulted experts. Due to this inspection frequency, the supervisory authorities and their experts obtain highly detailed knowledge about the installations to be monitored. The supervisory measures concern, besides controlling quality assurance and documentation, extensive on-site inspections to comprehend how safety-significant measures are implemented. The operator's responsibility for the safety of the plant remains unaffected by the examination procedures used. The BMU furthermore carries out additional controls in case of safety-significant issues that are intensified by the participation of RSK and GRS. This intense monitoring and the associated communication with all organisations involved is, by international comparison, a strength of the German system.

19 (vi) Reporting of events significant to safety

Legal and regulatory requirements

An obligation to report events significant to safety to the competent supervisory authority had already been specified in the original version of the Atomic Energy Act in 1959 [1A-3]. In 1975, a central reporting system was established by the *Länder* Committee for Nuclear Energy. Accordingly, the operators of nuclear power plants in Germany are obliged to report events to the supervisory authorities according to nation-wide applicable reporting criteria. In 1992, with the promulgation of the Nuclear Safety Officer and Reporting Ordinance [1A-17], the obligation of the operators of nuclear installations (nuclear power plants, research reactors with a thermal power of more than 50 kW and facilities of the nuclear fuel cycle) to report accidents, incidents or other events relevant to safety (reportable events) to the competent supervisory authority became legally formalised at the level of an ordinance.

The reporting criteria are included in appendices to the Nuclear Safety Officer and Reporting Ordinance [1A-17]. They include, in addition to incidents, events such as an unexpected adverse effects to safety features, e.g. by functional disturbances in the safety system or in systems or components relevant to safety. In addition, indications of systematic faults or deficiencies in this regard and deviations from specified conditions due to technical and construction-related deficiencies are reported.

Special reporting forms have been developed for recording and categorising reportable events by means of approximately 80 reporting criteria. They are subdivided into radiological criteria common for all nuclear installations and individual technical criteria applicable differently to nuclear power plants and to installations of the nuclear fuel cycle. For the reporting criteria, separate explanations exist for application to nuclear power plants, research reactors and facilities of the nuclear fuel cycle.

In recent years, the explanations on the reporting criteria for the nuclear power plants have been revised and further specified several times based on experience gained so far. The revision of the reporting criteria themselves currently takes place within the amendment of the Nuclear Safety Officer and Reporting Ordinance.

For practical considerations, the reporting criteria will, in future, be subdivided into separate technical parts for nuclear power plants, for research reactors, for facilities of the nuclear fuel cycle, for all decommissioned nuclear installations as well as for the storage of spent fuel elements.

The information required in the written report on the event is determined by the corresponding reporting form. It includes the immediately available information on the radiological situation, a summary of the safety significance of the event and additional details needed for those institutions evaluating the event. The uniform arrangement of data in the reporting form simplifies both the comparison of different reports and the transfer of their contents to the corresponding databases.

Reporting criteria and reporting procedures

Reportable events are assigned to one of the individual reporting categories through an initial engineering assessment, each. This approach particularly takes into account the aspect that the authority has to be able to take precautionary measures even before an in-depth safety review of the event.

Category S (immediate report - reporting deadline: without delay)
Category S events are those events on which the supervisory authority must be quickly informed in order to allow the authority to be able to initiate immediate investigations or other measures. Any event indicating an acute safety deficiency would also be placed in this category.

Category E (quick report - reporting deadline: within 24 hours)
Although events in Category E do not demand any immediate action by the supervisory authority, safety reasons require that their cause is identified and that remedial actions are taken within an appropriately short time period. These are, in general, events that may have a potential - but no direct - significance to safety.

Category N (normal report - reporting deadline: within 5 working days)
Category N is for those events with a low significance to safety. They are only slightly different from routine operational events while plant conditions and operation remain in full accord with the operating instructions. These events are, nevertheless, systematically evaluated with the purpose of detecting potential weak points at an early stage.

The reporting form has four distinct parts:

- General information on the nuclear installation and on the event,
- information on the radiological impacts,
- a narrative part with a detailed and properly arranged description and information about the measures taken or planned against recurrence, and
- identifying codification of the event and the affected components.

Any event that is categorised as reportable in accordance with the corresponding reporting criteria is reported by the plant operator to the competent *Land* supervisory authority.

The plant operator has the responsibility that the report is presented within the time period stipulated and that it contains the correct and complete information on the reportable event. The supervisory authority, in turn, after its initial evaluation of the circumstances, will report the event to the Federal Environment Ministry and, in parallel, to the Federal Office for

Radiation Protection (BfS) as central registration agency and the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS), an expert organisation working under on behalf of the Federal Environment Ministry. The categorisation of the event is reviewed by the Federal Office for Radiation Protection also at the federal level. In those cases where the information required in the reporting form is not completely available within the reporting deadline, the report will be marked as preliminary. The supervisory authority receives a completed report (final report) as soon as the missing data are available. The final reports, again, are forwarded to the Federal Environment Ministry, the Federal Office for Radiation Protection and also to the Gesellschaft für Anlagen und Reaktorsicherheit.

Reportable events are evaluated by the operators as well as by the authorities at several levels. This multiple-level and independent analysis ensures that each reportable event is evaluated properly and correctly.

Event statistics

Table 19-1 lists the reportable events having occurred over the last ten years, also indicating the German reporting categories and the INES rating.

Figures 19-1 and 19-2 show these events according to their kind of occurrence, spontaneously or detection during inspections and maintenance, and according to the operating condition at the time of detection of the event and the impact on operation. All events are included in these presentations, even those reported or re-classified at a later date. Figure 19-3 shows the development over the last ten years of the average number of reactor scrams, also indicating their essential causes.

Table 19-1 Number of reportable events in nuclear power plants according to categories

Year	Number	Reporting category			INES level		
		S	E	N	0	1	2
2000	94	0	2	92	91	3	0
2001	126	2	7	117	119	5	2
2002	167	0	10	157	154	13	0
2003	137	0	0	137	134	3	0
2004	153	0	6	147	146	7	0
2005	135	0	2	133	135	0	0
2006	130	0	4	126	130	0	0
2007	118	0	6	112	116	2	0
2008	92	0	4	88	91	1	0
2009	103	0	2	101	103	0	0

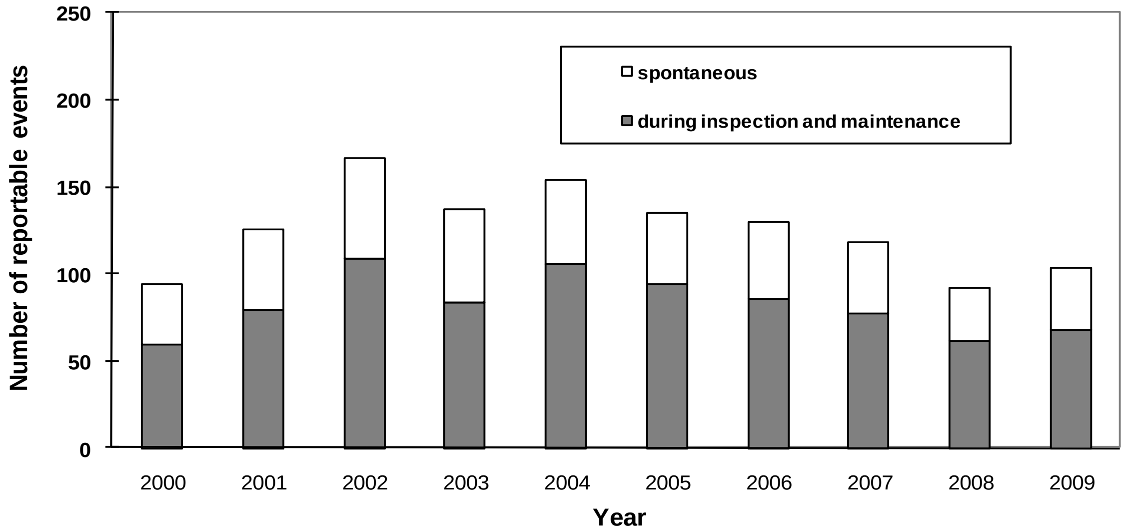


Figure 19-1 **Number of reportable events from nuclear power plants according to the kind of occurrence**

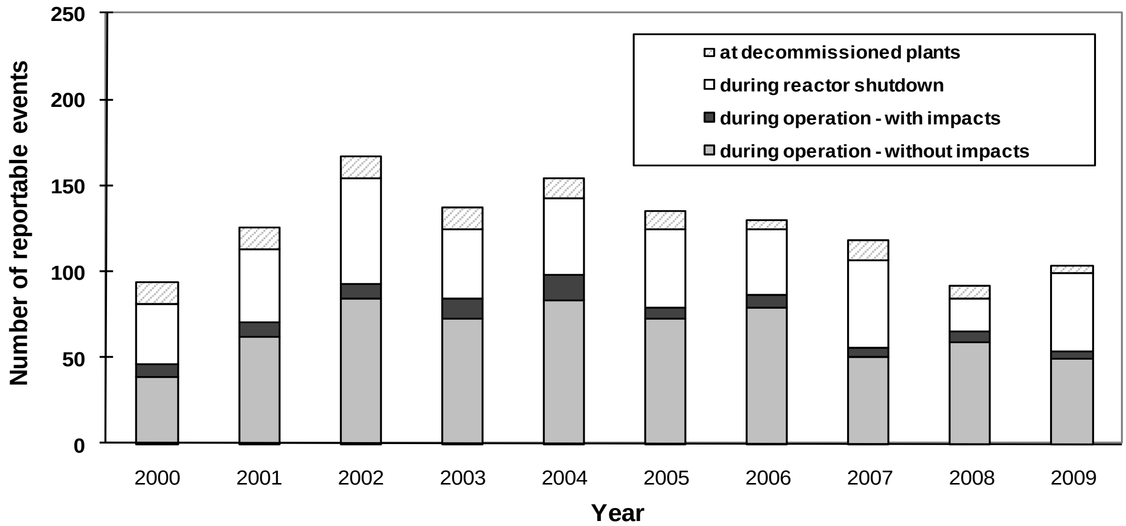


Figure 19-2 **Number of reportable events from nuclear power plants according to mode of and impacts on operation (power operation, start-up and shutdown operation)**

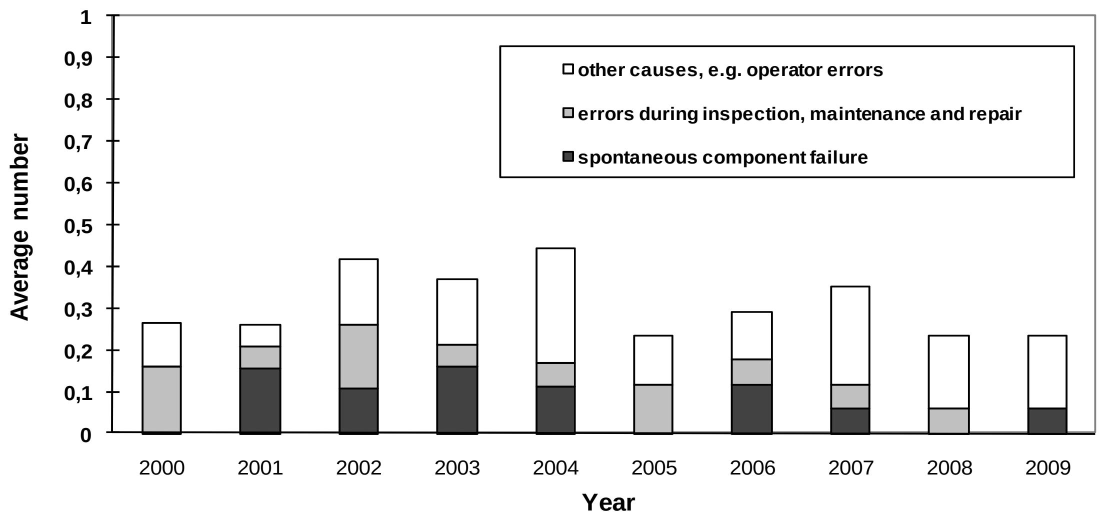


Figure 19-3 Average number of unplanned reactor trips per plant and year

Documentation and publication of the events

On behalf of the BMU, the Registration Centre of the BfS performs the central collection and documentation of information on all reportable events. The BfS performs an initial evaluation of the reported events and informs all nuclear authorities of the *Länder*, the expert organisations, the manufacturers and the operators of nuclear power plants as well as the general public in quarterly and annual reports about reportable events in nuclear power plants, research reactors and other nuclear installations. The database of the reportable events at the BfS is accessible to the nuclear supervisory authorities of the *Länder*, the BMU and GRS.

The operators inform the public about all reportable events in their nuclear power plants in an appropriate manner. Own staff are informed about reportable events by internal communication.

INES

Independent of the regulatory reporting procedure in accordance with the Reporting Ordinance, the plant operator also categorises the reportable events according to the seven levels of the International Nuclear and Radiological Event Scale (INES) of the IAEA.

The INES classification is reported together with the report according to the Nuclear Safety Officer and Reporting Ordinance. The plant manager is responsible for it. According to the Nuclear Safety Officer and Reporting Ordinance, the Nuclear Safety Officer has to check the report for correctness and completeness. Thus, the separation of functions reached by it is applicable to the INES classification

The INES Officer appointed by the BMU checks every report for correctness of the INES classification. The final decision on the classification is taken by the BMU and the INES Officer. The position of the INES Officer is currently being held by a GRS staff on behalf of the Federation.

Regulatory supervision

The procedures of regulatory supervision are contained in the explanations in Chapters 19 (iv) and 19 (vi).

If the supervisory authority obtains information on a fact which fulfils the reporting criteria according to the Nuclear Safety Officer and Reporting Ordinance or which might fulfil the reporting criteria, the matter is reviewed and assessed at the supervisory authority.

The information of the operator and possibly also the opinion of an expert consulted are evaluated by the supervisory authority in view of measures potentially to be taken. As a rule, further information is directly requested from the operator in addition to the reporting forms. This is sometimes done by telephone and, generally, in the context of a discussion of the event involving the authorised expert during a plant visit of the supervisory staff in charge. Events of general or fundamental significance are also consulted on in the RSK or the SSK at the instigation of the BMU.

After receipt and evaluation of all information on a reportable event, the supervisory authority establishes, if necessary, further remedial measures and precautions to be taken after thorough discussion with the operator.

The regulatory approach in the supervisory procedure has proven itself. However, it is continuously optimised.

19 (vii) Collecting, analysing and exchanging operating experience

Regulatory requirements

The Nuclear Safety Officer and Reporting Ordinance [1A-17] provides the essential basis for the evaluation of operating experience. It stipulates that, among others, the Nuclear Safety Officer shall co-operate in the evaluation

- of reportable events (Article 19 (vi))
- of other malfunctions in the own plant,
- of information on reportable events in other plants in terms of their significance for the own plant,
- and in an exchange of experience concerning operating experiences related to safety with the safety officers of other plants.

Evaluation of operating experience by the plant operator

On this issue, the operators report that the feedback of operating experience within the plant concerned is regulated plant specifically by appropriate procedural instructions. For internal events, information from the individual maintenance processes is used that is to be reported according to the maintenance regulation as part of the plant operating manual. All deficiencies and abnormal occurrences identified by the operating personnel are recorded and documented. A corresponding notice of malfunction is prepared which is followed up by designated staff according to their degree of priority and discipline concerned. Today, this is predominantly performed by means of an integrated computer-based plant management system. By this, it is ensured that a clearly defined workflow customised to the abnormal occurrence is followed whose basic principle is defined by the maintenance guideline [3.41] (→ Article 19 (iii)).

In meetings per working days, the deficiencies and abnormal occurrences are discussed and assessed and the potentially required measures are specified. The results of in-service inspections and maintenance as well as important measured values, which can indicate deviations of process parameters, are collected and documented. This allows a life history to be created for each component. These data form the basis for the safety analyses and, moreover, for a selected evaluation of individual components as well as for generic issues, for trend analyses, ageing management or the determination of reliability data for plant-specific probabilistic analyses.

This results in measures exceeding direct corrective action concerning deficiencies and abnormal occurrences. They also serve as a precaution against recurrence of deficiencies and abnormal occurrences of the same type. Moreover, in addition to these deficiencies and abnormal occurrences, all events (including near-misses) are reviewed for their potential with regard to experience feedback and, where necessary, are subjected to a comprehensive event analysis. The comprehensive event analysis determines the contributing man, technology and organisation and their interactions. This is to ensure that the experience feedback systematically considers all areas with a potential for improvements.

Generic information is accessible to the plant operators via an own network. The central interface is the Central Incident Reporting and Evaluation Office of VGB Power Tech (VGB-ZMA). Here, all reports from nuclear power plants in Germany are directly fed into a database to which also some plants of the manufacturer KWU (now AREVA NP) abroad are connected. Each plant performs y database synchronisation per working day. In addition to reportable events, occurrences below the reporting threshold but being of interest to the nuclear power plants are also recorded.

Moreover the VGB-ZMA represents the interface to two other institutions. It is connected to the WANO reporting system at the competent centre in Paris. The VGB-ZMA collects all incoming WANO reports and checks their safety significance for German nuclear power plants. Each month, a summary in German of selected reports is submitted to the plant operators to be checked for applicability to their plants.

In addition, there is a direct connection between the operating experience evaluation centre of AREVA NP and the VGB-ZMA. According to contractual agreements, AREVA NP has been supporting the plant operators in the evaluation of events since 1989. In addition to selected events from the VGB-ZMA, AREVA NP also evaluates GRS information notices and IRS reports. Applicability to and relevance for German plants is checked. Finally, AREVA NP reports via service information on new findings and studies concerning plant components supplied by it.

Further to the described direct reporting channels, there are different working groups and committees within the framework of VGB, in which the plant operators exchange their experiences. First to be mentioned in this context are the working groups “BWR” and “PWR”, in which the plant managers are organised, and the VGB working group “Nuclear Safety Officers and Human Factors” to discuss special events and the consequences to be drawn from them. The plant directors are organised in a committee primarily dealing with more general topics. For specialists, there are dedicated working groups in which particular and narrowly defined technical topics are discussed.

Evaluation of national and international operating experience

Evaluation of operating experience by the supervisory authorities

For safe operation and the tasks of nuclear regulatory supervision, an early identification of indications for problems relevant to nuclear safety is highly significant. Indications may be obtained, in particular, from the evaluation of plant operation and the safety-relevant operating experience as well as from the enhancement of safety-relevant knowledge and requirements due to the general technical progress. The authorities follow up these indications within the frame of the nuclear supervisory procedure. Through the regular supervision, the nuclear regulatory authorities and their authorised experts are informed about the actual operating condition and the basic operating processes. Moreover, the operators of nuclear power plants have to submit written operating reports to the supervisory authorities at regular intervals. These include data on the operating history, on inspection and maintenance measures, on radiation protection and on radioactive waste. In addition, there are reports of the plant operators on specific topics at regular intervals.

The plant operators also inform the competent nuclear supervisory authority, to some extent irrespective of their obligation to report (→ Article 19 (vi)), about findings from their plants below the reporting threshold and about findings outside their plants that may be of relevance with regard to safety-related issues. The nuclear supervisory authority evaluates these experiences principally with the methods also applied for reportable events with the objective to achieve, where possible, measures against recurrence of negative operating experiences in the plants of their jurisdiction. As far as these operating experiences or other findings made by the experts may also be of interest for the supervisory authorities in other *Länder*, appropriate information is made available. First, information is generally forwarded within the authorised expert organisations. The expert organisations informed this way, then check the findings for applicability to the plants for which they are competent as authorised expert and inform, where necessary, the respective nuclear authority by means of recommendations.

Against the background of all findings from regulatory supervision, however, the reportable events are the most important basis for the evaluation of operating experience by the authorities, in particular to assess safety deficiencies and to check applicability to other plants.

The *Land* supervisory authority and its expert organisation primarily analyse a reportable event regarding its safety significance and the remedial measures to be taken at the affected plant. In a second step, the *Land* authority and its expert organisation investigate the significance of the event for other plants in their area of supervision. In order to allow for an evaluation at national level beyond the borders of the *Länder*, the *Land* supervisory authority forwards information about the reported event to the BMU, the BfS and GRS (→ Article 19 (vi)).

Evaluation of operating experience on behalf of the BMU

Incident Registration Centre of the BfS

On behalf of the BMU, the BfS performs the central collection and documentation of information on all reportable events. The BfS performs an initial evaluation of the reported events including their categorisation, reports on it to the BMU every month (monthly reports) and informs all nuclear authorities of the *Länder*, the expert organisations, the manufacturers and the operators of nuclear power plants as well as the general public in quarterly and annual reports about all reportable events in nuclear power plants, research reactors and other nuclear installations. The database of the reportable events at the BfS is accessible to the nuclear supervisory authorities of the *Länder*, the BMU and GRS.

Evaluation of operating experience by GRS

All reportable events from German nuclear power plants are subjected to an evaluation by a GRS expert team. This also includes expert discussions at regular intervals.

In addition to the German experience, another important source for operating experience is found at the international level. For this reason, internationally available operating experience is also utilised intensively in Germany. An important source for safety-related findings from international operating experience is the Incident Reporting System (IRS) of the IAEA and the OECD/NEA. The Federal Republic of Germany actively participates in this reporting system. The events reported are systematically evaluated by GRS on behalf of the BMU regarding potential applicability to German plants. In monthly reports, short descriptions for every IRS event are given and commented regarding applicability to German nuclear power plants. These monthly reports - together with the corresponding original reports by IRS - are sent to the supervisory authorities and expert organisations as well as to the operators and other competent institutions. In addition, GRS prepares annual reports containing detailed descriptions and evaluations of events of particular significance for German plants. These annual reports, comprising about 20 selected IRS reports, are distributed in the same way as the quarterly reports. The operators evaluate these reports with regard to the applicability to their own plants.

Review of applicability to other plants

GRS prepares information notices for all those events in German and foreign nuclear power plants where the in-depth analyses show a current or potential significance and applicability to the safety of other plants. These information notices are submitted to the supervisory authorities and expert organisations, the plant operators, the manufacturers and other institutions on behalf of the BMU. The information notices cover a description of the circumstances of the event, the results of the root cause analysis, an evaluation regarding safety significance, a description of the measures taken or planned and, as an essential element, recommendations regarding investigations and, where appropriate, remedial measures to be taken at other plants. The plant operators prepare a comment on each information notice for the competent supervisory authority with special emphasis on the implementation of the recommendations. These comments are evaluated by authorised experts on behalf of the competent supervisory authorities. If the *Länder* are requested to provide plant-specific information feedback on behalf of the BMU due to the safety significance, they report to the BMU on the implementation of the recommendations given in the information notices. GRS collects all comments on the information notices and prepares an assessment with particular regard to additional findings. These findings, again, are usually made available to the above addressees of the information notices by means of an annual report.

In case of special events at nuclear power plants abroad, GRS prepares, on demand of the BMU, statements in the short term on the safety significance and applicability to German nuclear power plants. In case of events that might require immediate action of the authorities, the BMU informs the authorities of the *Länder* directly.

Moreover, GRS performs a generic assessment of German and international operating experience on behalf of the BMU. Safety issues not to be assigned to a single event but to a group of events (event collective) and general safety issues arising from an event are subject to an in-depth analysis. The results and conclusions from the generic assessments are documented in reports being distributed in the same way as the information notices. The plant operators again perform a plant-specific evaluation of these reports and, if applicable, implement the issue.

The generic evaluations also include systematic precursor analyses performed for reportable events in German plants by GRS on behalf of the BMU. The purpose is the identification of weak points by probabilistic methods and trend analyses of the safety status. Following international practice, GRS developed a methodology for performing trend analyses of parameters important to safety which can be derived from the reportable events.

Exchange of experience

On both sides, the operators as well as the authorities and their expert organisations, there are different working groups meeting regularly for discussion of the operating experience and of the conclusions drawn with respect to safety and to the general applicability of plant-specific evaluations. Moreover, the reports of the operators on plant operation and experience evaluation as well as the information notices and evaluations of GRS on events in Germany and abroad are also discussed regularly by the RSK.

International databases

Special events at German nuclear power plants being also of interest for the safety of nuclear power plants in other countries according to the INES and IRS manual, are reported to the IAEA by GRS in co-ordination with the BMU, the competent *Land* authority and the plant operators. Events classified INES Level 2 and higher are to be reported to IAEA-NEWS in the short term (within 24 hours as specified). Reports with INES classification below Level 2 should be forwarded if the events are of public, international interest. Since the introduction of INES, Germany has reported four events in nuclear power plants classified as INES Level 2. In addition, the *Länder* receive in-depth information about events in nuclear power plants abroad with INES Level 2 or higher in the Working Group Supervision of NPP Operation (→ Article 8).

Regulatory supervision

The regulatory procedures for recording, processing, assessing and forwarding safety-relevant operating experience from German nuclear installations have proven to be effective. They constitute good practice at the international level. However, experiences also show that regular review and enhancement of the procedures are important to ensure that, in the long run, new sources of knowledge are considered in the experience feedback and knowledge gaps identified can be closed.

The independent review by different parties involved is to ensure the high reliability of the safety assessment.

Programmes for the exchange of experience

With some countries (Brazil, Czech Republic, France, The Netherlands, Spain, Switzerland etc.) there is also a direct bilateral co-operation. This includes an intensive exchange of operating experience between the respective experts (→ Article 17 (iv)).

19 (viii) Management of radioactive waste and spent fuel

Legal and regulatory requirements

Pursuant to Section 9a of the Atomic Energy Act [1A-3], anyone who produces residual radioactive material shall make provisions to ensure that they are utilised without detrimental effects or are disposed of as radioactive waste in an orderly manner.

Storage of spent fuel elements

The spent fuel elements are temporarily stored in the wet storage pools of the nuclear power plants. Here, subcriticality and cooling of the fuel elements in the wet storage pools as well as the protection against external hazards are ensured. According to requirements laid down in the licences, the spent fuel pool must always have free capacity of one core loading to enable the complete unloading of the core at any time. The free capacity for fuel storage in one nuclear power plant cannot be used by any other plant. Exceptions to this have been permitted for the double-unit plants Neckarwestheim and Philippsburg. In the case of the Obrigheim NPP, a licence was granted in 1998 for the operation of an already previously built additional fuel pool in the earthquake-protected emergency building outside the reactor building.

In order to minimise the number of transports of spent fuel elements, the plant operators have applied for the construction of local interim storage facilities in the years 1998 to 2000 (→ Table 19-2). For the Obrigheim site, an on-site interim storage facility was also applied for in 2005 to allow for the clearance of the wet storage facility within the course of plant decommissioning. The granting of the storage licences for spent fuel elements at the local interim storage facilities falls within the competence of the BfS. The storage facilities are dry storage facilities for spent fuel elements in shipping and storage casks. The capacity of these storage facilities is designed to accommodate all spent fuel elements accumulating until final cessation of nuclear power plant operation and to store them also after decommissioning of the respective plant until commissioning of a repository. The time of operation is limited to 40 years, beginning with the emplacement of the first cask. Twelve local interim storage facilities have been licensed and are in operation.

Table 19-2 Local interim storage facilities for spent fuel elements

Interim storage on site of nuclear power plant	Granting of 1st licence pursuant to Section 6 of the Atomic Energy Act	Capacity HM [Mg]	Storage positions for casks	Start of construc-tion	Commis-sioning
Biblis (KWB)	22.09.2003	1400	135	01.03.2004	18.05.2006
Brokdorf (KBR)	28.11.2003	1000	100	05.04.2004	05.03.2007
Brunsbüttel (KKB)	28.11.2003	450	80	07.10.2003	05.02.2006
Grafenrheinfeld (KKG)	12.02.2003	800	88	22.09.2003	27.02.2006
Grohnde (KWG)	20.12.2002	1000	100	10.11.2003	27.04.2006
Gundremmingen (KRB)	19.12.2003	1850	192	23.08.2004	25.08.2006
Isar (KKI)	22.09.2003	1500	152	14.06.2004	12.03.2007
Krümmel (KKK)	19.12.2003	775	80	23.04.2004	14.11.2006
Lingen (KKE)	06.11.2002	1250	125	18.10.2000	10.12.2002
Neckarwestheim (GKN)	22.09.2003	1600	151	17.11.2003	06.12.2006
Philippsburg (KKP)	19.12.2003	1600	152	17.05.2004	19.03.2007
Unterweser (KKU)	22.09.2003	800	80	19.01.2004	18.06.2007
Obrigheim (KWO)	Applied for in 2005	100	15		

Treatment, conditioning and disposal of radioactive waste

Any activities concerning the management of radioactive waste are subject to regulatory supervision by the respective *Länder* authorities. The plant operator submits a conceptual waste programme to the competent supervisory authority; it accounts for all waste accumulated in the restricted access area during operation of the nuclear power plant. Adequate operational management by the plant operators and corresponding planning for major plant revisions (refuelling outages), reduces the volume of radioactive waste substantially. Regarding treatment, conditioning and disposal of radioactive waste, the plant operators are partly supported by specialised outside contractors.

From the time of its generation, the accumulated radioactive material is sorted according to radioactivity and type. This is done primarily with the objective to recycle - with or without restrictions - as much of the material as possible after decontamination if necessary and after clearance measurement, or to provide for their disposal as conventional waste, if the prescribed limits are not exceeded.

Packaging, pre-treatment and conditioning of the radioactive waste is carried out with qualified procedures and, as far as possible and practicable, on site.

Treatment and conditioning is always performed with regard to the requirements of subsequent disposal. Pre-treatment and treatment equipment (e.g. to concentrate, sort, compact and package) is available at all nuclear power plants. Accordingly, non-combustible liquid waste is concentrated, and the non-combustible solids are compacted by high pressure. In many cases, conditioning in compliance with the requirements for repositories is performed by outside contractors that have mobile equipment available (e.g. in-drum drying facilities for liquid concentrates, remote underwater disassembling equipment for intermediate level wastes) and will transport this equipment to the nuclear power plant. The combustion of combustible waste and conditioning (cementing) of the resulting ashes is performed by outside contractors in off-site plants. The conditioned waste packages are returned to the nuclear power plants for storage at on-site facilities or transported to a central (external) interim storage facility.

Minimisation of waste volumes

Pre-treatment and treatment of radioactive waste that cannot be released from regulatory control minimises its volume and converts the primary waste to intermediate products that can be handled and properly conditioned for final disposal. All arising radioactive waste is sorted according to radioactivity and type and is documented. The Radiation Protection Ordinance and the regulatory guideline on the control of residual radioactive material and radioactive waste [3-60] specify the sorting criteria and the requirements regarding registration, determination of activity and documentation. By doing so, the waste producers will always be able to give information on the amount of activity and the storage place of the radioactive waste.

Waste management

Germany is member of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [1E-3.2]. Report on the activities on radioactive waste management in Germany was last given within the framework of the Review Meeting under this Convention in May 2009. The next report will be prepared for the Review Meeting in May 2012.

Clearance

The clearance levels for radioactive material with minor activity and the clearance procedure are specified in the Radiation Protection Ordinance [1A-8]. For about 300 radionuclides, the Radiation Protection Ordinance prescribes mass-specific clearance levels for solid and liquid material and clearance levels for surface contamination, for the clearance of buildings and land areas, as well as for the clearance for disposal at a domestic waste dump or an incineration plant on the basis of the 10 μSv-concept. Clearance is regulated by the supervisory authority. The measurements required for it are performed by the plant operator and are subject to the supervision by the competent *Land* authority, which also performs control measurements.

Regulatory supervision

The BfS performs an annual survey on the accumulated radioactive waste in Germany, including the volume of radioactive waste produced at the nuclear power plants. The BfS generally differentiates between radioactive waste that produces heat and such whose heat generation is negligible.

Article 19: Progress and changes since 2007

Amendment of KTA safety standards: Requirements for the operating manual, testing manual and the accident management manual

The provisions in safety standard [KTA 1201] on safety specifications were revised under consideration of the further development of knowledge and the operating requirements. Within the course of this revision, safety standard [KTA 1201] was basically restructured with additional requirements for plant start-up and shutdown and plant outage (shutdown states). Moreover, requirements were added on regulations for the control of design basis accidents during shutdown states. The requirements for the protection goal oriented part of the operating manual and transition to the accident management manual were also modified.

The provisions in safety standard [KTA 1202] “Requirements for the Testing Manual” were revised under consideration of the further development of knowledge and the operating experience.

Furthermore, a new safety standard [KTA 1203] was developed on requirements for the accident management manual. The requirement of safety standard [KTA 1203] was subdivided into Part 1 on organisational regulations and Part 2 on accident management measures. Part 1 includes requirements on the structure of the emergency organisation, distribution of tasks, competencies and responsibilities. In addition, the criteria and procedures for calling in the emergency organisation and its implementation and deactivation are to be described. Furthermore, location, establishment and equipment of the emergency organisation are to be specified. The co-operation with external organisations and the regulations on access for persons and vehicles as well as the radiological monitoring are to be described. In Part 2, each accident management measure is to be described in a short overview. In support of the performers, flow diagrams, instructions for activities at the control room and on site as well as take-away copies for activities on site are to be provided.

Other amendments of KTA safety standards due to operating experiences

In response to international and national events, the KTA decided to develop a safety standard on management systems. The KTA safety standard is largely completed and will be made available to the KTA groups in 2010 for discussion. The draft safety standard outlines the general requirements (process orientation, integrated management system as well as monitoring, assessment and improvement) for management systems. Another chapter specifies the requirements concerning the responsibilities and tasks of the corporate management and the plant management. Subsequent to these basic requirements, there is a larger chapter on requirements for process contents and sequences where requirements are formulated for practically all processes relevant to safety. This includes, e.g., operation of the plant, modifications of the plant, its operation, its organisation, maintenance, experience feedback, handling of fuel elements and other core components as well as radioactive waste management.

In response to the event in the Swedish Forsmark plant in 2006 with a loss of offsite power and the advancement of the state of knowledge on station power supply of the nuclear power plants, the three safety standards of the KTA safety standards series 37 are being revised.

The KTA safety standard on ageing management [KTA 1403] is currently being developed.

Reporting procedures

The plant operators improved their information system regarding the faster recording and assessment of safety-relevant occurrences abroad.

Article 19: Future activities

Germany will actively participate in the further development of the reporting and evaluation systems for operating experience at international organisations. In the future, continuous information of the public via the BfS website is planned.

Regarding the feedback of operating experience, the following is planned:

- Improvement of feedback subsequent to information notices with regard to the content- and time-related boundary conditions,
- strengthening of the activities of the *Länder* in international co-operation,
- comparisons with the requirements and processes for experience feedback at other supervisory authorities with the aim to identify improvement potential,
- evaluation of events below the reporting threshold.

The contents of Guidelines Concerning the Requirements for Safety Specifications for Nuclear Power Plants [3-4] are to be adapted to safety standard [KTA 1201].

Appendix 1 Nuclear power plants

Appendix 1-1 Nuclear power plants in operation

	Nuclear power plants in operation Site	a) Licensee b) Manufacturer c) Major shareholder	Type Gross-capacity MWe	Constr. line	a) Date of application- b) First criticality
1	Biblis A (KWB A) Biblis Hessen	a) RWE Power b) KWU c) RWE Power 100%	PWR 1225	2	a) 11.06.1969 b) 16.07.1974
2	Biblis B (KWB B) Biblis Hessen	a) RWE Power b) KWU b) RWE Power 100%	PWR 1300	2	a) 03.05.1971 b) 25.03.1976
3	Neckarwestheim 1 (GKN 1) Neckarwestheim Baden-Württemberg	a) EnBW Kernkraft (EnKK) b) KWU c) EnKK 100%	PWR 840	2	a) 02.04.1971 b) 26.05.1976
4	Brunsbüttel (KKB) Brunsbüttel Schleswig-Holstein	a) Kernkraftwerk Brunsbüttel b) AEG/KWU c) VENE 66,7%, E.ON Kernkraft 33,3%	BWR 806	69	a) 10.11.1969 b) 23.06.1976
5	Isar 1 (KKI 1) Essenbach Bayern	a) E.ON Kernkraft b) KWU c) E.ON Kernkraft 100%	BWR 912	69	a) 25.06.1971 b) 20.11.1977
6	Unterweser (KKU) Esenshamm Niedersachsen	a) E.ON Kernkraft b) KWU c) E.ON Kernkraft 100%	PWR 1410	2	a) 07.04.1971 b) 16.09.1978
7	Philippsburg 1 (KKP 1) Philippsburg Baden-Württemberg	a) EnBW Kernkraft (EnKK) b) KWU c) EnKK 100%	BWR 926	69	a) 20.02.1970 b) 09.03.1979
8	Grafenrheinfeld (KKG) Grafenrheinfeld Bayern	a) E.ON Kernkraft b) KWU c) E.ON Kernkraft 100%	PWR 1345	3	a) 07.06.1973 b) 09.12.1981
9	Krümmel (KKK) Krümmel Schleswig-Holstein	a) Kernkraftwerk Krümmel b) KWU c) VENE 50%, E.ON Kernkraft 50%	BWR 1402	69	a) 18.02.1972 b) 14.09.1983
10	Gundremmingen B (KRB B) Gundremmingen Bayern	a) Kernkraftwerk Gundremmingen b) KWU c) RWE Power 75%, E.ON Kernkraft 25%	BWR 1344	72	a) 15.03.1974 b) 09.03.1984
11	Grohnde (KWG) Grohnde Niedersachsen	a) E.ON Kernkraft b) KWU c) E.ON Kernkraft 83,3%, Stadtwerke Bielefeld 16,7%	PWR 1430	3	a) 03.12.1973 b) 01.09.1984

Appendix 1-1 Nuclear power plants in operation

	Nuclear power plants in operation Site	a) Licensee b) Manufacturer c) Major shareholder	Type Gross-capacity MWe	Constr. line	a) Date of application- b) First criticality
12	Gundremmingen C (KRB C) Gundremmingen Bayern	a) Kernkraftwerk Gundremmingen b) KWU c) RWE Power 75%, E.ON Kernkraft 25%	BWR 1344	72	a) 15.03.1974 b) 26.10.1984
13	Philippsburg 2 (KKP 2) Philippsburg Baden-Württemberg	a) EnBW Kernkraft (EnKK) b) KWU c) EnKK 100%	PWR 1458	3	a) 24.06.1975 b) 13.12.1984
14	Brokdorf (KBR) Brokdorf Schleswig-Holstein	a) E.ON Kernkraft b) KWU c) E.ON Kernkraft 80%, VENE 20%	PWR 1480	3	a) 12.03.1974 b) 08.10.1986
15	Isar 2 (KKI 2) Essenbach Bayern	a) E.ON Kernkraft b) KWU c) E.ON Kernkraft 75%, Stadtwerke München 25%	PWR 1485	4 Konvoi	a) 13.02.1979 b) 15.01.1988
16	Emsland (KKE) Lingen Niedersachsen	a) Kernkraftwerke Lippe-Ems b) KWU c) RWE Power 87,5%, E.ON Kernkraft 12,5%	PWR 1400	4 Konvoi	a) 28.11.1980 b) 14.04.1988
17	Neckarwestheim 2 (GKN 2) Neckarwestheim Baden-Württemberg	a) EnBW Kernkraft (EnKK) b) KWU c) EnKK 100%	PWR 1400	4 Konvoi	a) 27.11.1980 b) 29.12.1988

	Nuclear power plants of construction line 1 (under decommissioning)				
	Nuclear power plants permanently shut down Site	a) Last licensee b) Manufacturer c) Licensee for decommissioning	Type Gross capacity MWe	Constr. line	a) First criticality b) Date of shutdown
	Obrigheim (KWO) Obrigheim Baden-Württemberg	a) EnBW Kernkraft (EnKK) b) Siemens c) EnBW Kernkraft (EnKK)	PWR 357	1	a) 22.09.1968 b) 11.05.2005
	Stade (KKS) Stade Niedersachsen	a) E.ON Kernkraft b) KWU c) E.ON Kernkraft	PWR 672	1	a) 08.01.1972 b) 14.11.2003

Appendix 1-2 Nuclear power plants permanently shut down

	Nuclear power plants permanently shut down *) Site	a) Last licensee b) Manufacturer c) Licensee for decommissioning	Type Gross capacity MWe	a) First criticality b) Date of shutdown
1	Versuchsatomkraftwerk (VAK) Kahl Bayern	a) Versuchsatomkraftwerk Kahl b) AEG/General Electric c) VAK	BWR 16	a) 13.11.1960 b) 25.11.1985
2	Mehrzweckforschungs-reaktor (MZFR) Eggenstein-Leopoldshafen Baden-Württemberg	a) Kernkraftwerk Betriebsgesellschaft mbH b) Siemens/KWU c) Wiederaufarbeitungsanlage Karlsruhe Rückbau- und Entsorgungs-GmbH	Pressurized heavy water reactor 57	a) 29.09.1965 b) 03.05.1984
3	Rheinsberg (KKR) Rheinsberg Brandenburg	a) Energiewerke Nord b) VEB Kernkraftwerksbau Berlin c) Energiewerke Nord	PWR (VVER) 70	a) 11.03.1966 b) 01.06.1990
4	Gundremmingen A (KRB A) Gundremmingen Bayern	a) Kernkraftwerk RWE-Bayernwerk b) AEG/General Electric c) Kernkraftwerk Gundremmingen	BWR 250	a) 14.08.1966 b) 13.01.1977
5	Atomversuchskraftwerk (AVR) Jülich Nordrhein-Westfalen	a) Arbeitsgemeinschaft Versuchsreaktor b) BBC/Krupp Reaktorbau (BBK) c) AVR	HTR 15	a) 26.08.1966 b) 31.12.1988
6	Lingen (KWL) Lingen Niedersachsen	a) Kernkraftwerk Lingen b) AEG/KWU c) Kernkraftwerk Lingen	BWR 252	a) 31.01.1968 b) 05.01.1977
7	Obrigheim (KWO) Obrigheim Baden-Württemberg	a) EnBW Kernkraft (EnKK) b) Siemens c) EnBW Kernkraft (EnKK)	PWR 357	a) 22.09.1968 b) 11.05.2005
8	Heißdampfreaktor (HDR) Großwelzheim Bayern	a) Forschungszentrum Karlsruhe b) AEG	Super heated steam cooled reactor 25	a) 14.10.1969 b) 20.04.1971 completely dismantled
9	Würgassen (KWW) Würgassen Nordrhein-Westfalen	a) E.ON Kernkraft b) AEG/KWU c) E.ON Kernkraft	BWR 670	a) 22.10.1971 b) 26.08.1994
10	Stade (KKS) Stade Niedersachsen	a) E.ON Kernkraft b) KWU c) E.ON Kernkraft	PWR 672	a) 08.01.1972 b) 14.11.2003

Appendix 1-2 Nuclear power plants permanently shut down

	Nuclear power plants permanently shut down *) Site	a) Last licensee b) Manufacturer c) Licensee for decommissioning	Type Gross capacity MWe	a) First criticality b) Date of shutdown
11	Niederaichbach (KKN) Niederaichbach Bayern	a) Forschungszentrum Karlsruhe b) Siemens	Pressure tube reactor 106	a) 17.12.1972 b) 31.07.1974 completely dismantled
12	Greifswald 1 (KGR 1) Lubmin Mecklenburg-Vorpommern	a) Energiewerke Nord b) VEB Kombinat Kraftwerksanlagenbau c) Energiewerke Nord	PWR (VVER) 440	a) 03.12.1973 b) 18.12.1990
13	Greifswald 2 (KGR 2) Lubmin Mecklenburg-Vorpommern	a) Energiewerke Nord b) VEB Kombinat Kraftwerksanlagenbau c) Energiewerke Nord	PWR (VVER) 440	a) 03.12.1974 b) 14.02.1990
14	Greifswald 3 (KGR 3) Lubmin Mecklenburg-Vorpommern	a) Energiewerke Nord b) VEB Kombinat Kraftwerksanlagenbau c) Energiewerke Nord	PWR (VVER) 440	a) 06.10.1977 b) 28.02.1990
15	Kompakte natriumgekühlte Reaktoranlage (KNK II) Karlsruhe Baden-Württemberg	a) Kernkraftwerkbetriebs-gesellschaft b) Interatom c) Wiederaufarbeitungsanlage Karlsruhe Rückbau- und Entsorgungs-GmbH	FBR 21	a) 10.10.1977 b) 23.08.1991
16	Greifswald 4 (KGR 4) Lubmin Mecklenburg-Vorpommern	a) Energiewerke Nord b) VEB Kombinat Kraftwerksanlagenbau c) Energiewerke Nord	PWR (VVER) 440	a) 22.07.1979 b) 02.06.1990
17	Thorium-Hochtemperatur-reaktor (THTR 300) Hamm-Uentrop Nordrhein-Westfalen	a) Hochtemperatur Kernkraftwerk b) BBC/HRB/NUKEM c) Hochtemperatur Kernkraft GmbH (HKG)	HTR 308	a) 13.09.1983 b) 29.09.1988
18	Mülheim-Kärlich (KMK) Mülheim-Kärlich Rheinland-Pfalz	a) RWE Power b) BBR c) RWE Power	PWR 1302	a) 01.03.1986 b) 09.09.1988
19	Greifswald 5 (KGR 5) Lubmin Mecklenburg-Vorpommern	a) Energiewerke Nord b) VEB Kombinat Kraftwerksanlagenbau c) Energiewerke Nord	PWR (VVER) 440	a) 26.03.1989 b) 30.11.1989

Projects stopped

Appendix 1-2 Nuclear power plants permanently shut down

	Nuclear power plants permanently shut down *) Site	a) Last licensee b) Manufacturer c) Licensee for decommissioning	Type Gross capacity MWe	a) First criticality b) Date of shutdown
20	Greifswald 6 (KGR 6) Lubmin Mecklenburg-Vorpommern	a) Energiewerke Nord b) VEB Kombinat Kraftwerksanlagenbau	PWR (VVER) 440	Project stopped
21	Greifswald 7 (KGR 7) Lubmin Mecklenburg-Vorpommern	a) Energiewerke Nord b) VEB Kombinat Kraftwerksanlagenbau	PWR (VVER) 440	Project stopped t
22	Greifswald 8 (KGR 8) Lubmin Mecklenburg-Vorpommern	a) Energiewerke Nord b) VEB Kombinat Kraftwerksanlagenbau	PWR (VVER) 440	Project stopped
23	SNR 300 Kalkar Nordrhein-Westfalen	a) Schnell-Brüter Kernkraftwerksgesellschaft b) INTERATOM/ BELGONUCLEAIRE/ NERATOOM	FBR 327	Project stopped 20.03.1991
24	Stendal A Stendal Sachsen-Anhalt	a) Altmark Industrie b) VEB Kombinat Kraftwerksanlagenbau	PWR (VVER) 1000	Project stopped
25	Stendal B Stendal Sachsen-Anhalt	a) Altmark Industrie b) VEB Kombinat Kraftwerksanlagenbau	PWR (VVER) 1000	Project stopped

*) decommissioned or shut down

Appendix 2 Research reactors

Appendix 2-1 Research reactors in operation

	Research reactor Site	Licensee	Reactor type Thermal output th. n-flow [$cm^{-2}s^{-1}$]	First criticality
1	FRG-1 Geesthacht Schleswig-Holstein	GKSS-Forschungszentrum Geesthacht GmbH	Swimming pool / MTR 5 MW $< 1,4 \cdot 10^{14}$	23.10.1958
2	SUR Stuttgart Baden-Württemberg	Universität Stuttgart Institut für Kernenergetik und Energiesysteme	SUR-100 100 mW $< 5 \cdot 10^{6}$	24.08.1964
3	FRMZ Mainz Rheinland-Pfalz	Universität Mainz Institut für Kernchemie	Swimming pool/ TRIGA Mark II 0,1 MW $< 4 \cdot 10^{12}$	03.08.1965
4	SUR Aachen Nordrhein-Westfalen	RWTH Aachen Institut für elektrische Anlagen und Energiewirtschaft	SUR-100 100 mW $< 5 \cdot 10^{6}$	22.09.1965 Nuclear fuel unloaded
5	SUR Ulm Baden-Württemberg	Fachhochschule Ulm Labor für Strahlenmess-technik und Reaktortechnik	SUR-100 100 mW $< 5 \cdot 10^{6}$	01.12.1965
6	SUR Hannover Niedersachsen	Universität Hannover Institut für Werkstoffkunde	SUR-100 100 mW $< 5 \cdot 10^{6}$	09.12.1971 Nuclear fuel unloaded
7	SUR Furtwangen Baden-Württemberg	Fachhochschule Furtwangen	SUR-100 100 mW $< 5 \cdot 10^{6}$	28.06.1973
8	BER II Berlin	Helmholtz-Zentrum Berlin für Materialien und Energie GmbH	Swimming pool / MTR 10 MW $< 1,5 \cdot 10^{14}$	09.12.1973
9	AKR-2 Dresden Sachsen	Technische Universität Dresden Institut für Energietechnik	SUR-type 2 W $< 3 \cdot 10^{7}$	22.03.2005 (AKR-1: 28.07.1978)
10	FRM-II Garching Bayern	Technische Universität München	Swimming pool / Compact core 20 MW $< 8 \cdot 10^{14}$	02.03.2004

Appendix 2-2 Research reactors in decommissioning or decommissioning decided

	Research reactors in decommissioning or decommissioning decided Site	Licensee	Reactor type therm. output th. n-flow [$cm^{-2}s^{-1}$]	a) First criticality b) Shutdown c) Status
1	FRM Garching Bayern	Technische Universität München	Swimming pool / MTR 4 MW $< 7{\cdot}10^{13}$	a) 31.10.1957 b) 28.07.2000 c) 14.12.1998 AS[1]
2	RFR Rossendorf Sachsen	Verein für Kern-forschungstechnik und Analytik Rossendorf (VKTA)	Tank type / WWR-S(M) 10 MW $< 1{,}2{\cdot}10^{14}$	a) 16.12.1957 b) 27.06.1991 c) 01.02.2005 4. TSG[2]
3	FR-2 Karlsruhe Baden-Württemberg	Wiederaufarbeitungs-anlage Karlsruhe Rückbau- und Entsorgungs-GmbH	Tank Typ/ D_2O-reactor 44 MW $< 10^{14}$	a) 07.03.1961 b) 21.12.1981 c) 20.11.1996 SE[3]
4	FRJ-2 (DIDO) Jülich Nordrhein-Westfalen	Forschungszentrum Jülich	Tank type/ D_2O-Reactor 23 MW $< 10^{14}$	a) 14.11.1962 b) 02.05.2006 c) 27.04.2007 AS
5	FRG-2 Geesthacht Schleswig-Holstein	GKSS-Forschungszentrum Geesthacht	Swimming pool / MTR 15 MW $< 1{,}5{\cdot}10^{14}$	a) 16.03.1963 b) 28.01.1993 c) 17.01.1995 Licence for decomm. and partial dismantling
6	SUR Berlin	Technische Universität Berlin Institut für Energietechnik	SUR-100 100 mW $< 5{\cdot}10^{6}$	a) 26.07.1963 b) 15.10.2007 c) 01.12.2008 SG[4]
7	FMRB Braunschweig Niedersachsen	Physikalisch Technische Bundesanstalt Braunschweig	Swimming pool / MTR 1 MW $< 6{\cdot}10^{12}$	a) 03.10.1967 b) 19.12.1995 c) facility released
8	FRN Oberschleißheim Bayern	Helmholtz Zentrum München – Deutsches Forschungszentrum für Umwelt und Gesundheit GmbH	Swimming pool / TRIGA Mark III 1 MW $< 3{\cdot}10^{13}$	a) 23.08.1972 b) 16.12.1982 c) 24.05.1984 SE

[1] AS Application for decommissioning

[2] TSG Licence for partial decommissioning

[3] SE Safe enclosure

[4] SG Licence for decommissioning

Appendix 2-3 Research reactors, completely dismantled

	Decommissioned or dismantled research reactors Site	Licensee	Reactor type therm. output th. n-flow [$cm^{-2}s^{-1}$]	a) First criticality b) Shutdown
1	FRF 1 Frankfurt Hessen	Johann Wolfgang Goethe Universität Frankfurt	Homogeneous reactor 10 kW $< 10^{12}$	a) 10.01.1958 b) 19.03.1968
2	BER I Berlin	Helmholtz-Zentrum Berlin für Materialien und Energie GmbH	Homogeneous reactor 50 kW $< 10^{12}$	a) 24.07.1958 b) 1972
3	SAR Garching Bayern	Technische Universität München	Argonaut 1 kW $< 2{,}4 \cdot 10^{11}$	a) 23.06.1959 b) 31.10.1968
4	SUA Garching Bayern	Technische Universität München	Subcritical Assembly	a) 6/1959 b) 1968
5	AEG Prüfreaktor PR-10 Karlstein Bayern	Kraftwerk Union	Argonaut 180 W $2{,}5 \cdot 10^{10}$	a) 27.01.1961 b) 1976
6	FRJ-1 (MERLIN) Jülich Nordrhein-Westfalen	Forschungszentrum Jülich	Swimming pool / MTR 10 MW $< 10^{14}$	a) 24.02.1962 b) 22.03.1985
7	SUR-M Garching Bayern	Technische Universität München	SUR-100 100 mW $< 5 \cdot 10^{6}$	a) 28.02.1962 b) 10.08.1981
8	RRR Rossendorf Sachsen	Verein für Kernforschungs-technik und Analytik Rossendorf (VKTA)	Argonau 1 kW $< 1{,}5 \cdot 10^{11}$	a) 16.12.1962 b) 25.09.1991
9	STARK Eggenstein-Leopoldshafen Baden-Württemberg	Karlsruher Institut für Technologie	Argonaut 10 W $< 1{,}4 \cdot 10^{8}$	a) 11.01.1963 b) 3/1976
10	SUR-DA Darmstadt Hessen	Technische Hochschule Darmstadt	SUR-100 100 mW $< 5 \cdot 10^{6}$	a) 23.09.1963 b) 22.02.1985
11	ANEX Geesthacht Schleswig-Holstein	GKSS-Forschungszentrum Geesthacht	Critical assembly 100 W $< 2 \cdot 10^{8}$	a) 5/1964 b) 05.02.1975

Appendix 2-3 Research reactors, completely dismantled

	Decommissioned or dismantled research reactors Site	Licensee	Reactor type therm. output th. n-flow [$cm^{-2}s^{-1}$]	a) First criticality b) Shutdown
12	SUAK Eggenstein-Leopoldshafen Baden-Württemberg	Karlsruher Institut für Technologie	Subcritical assembly	a) 20.11.1964 b) 07.12.1978
13	SUR-HH Hamburg	Fachhochschule Hamburg	SUR-100 100 mW $< 5 \cdot 10^6$	a) 15.01.1965 b) 8/1992
14	SUR-KA Eggenstein-Leopoldshafen Baden-Württemberg	Karlsruher Institut für Technologie	SUR-100 100 mW $< 5 \cdot 10^6$	a) 07.03.1966 b) 9/1996
15	SUR-KI Kiel Schleswig-Holstein	Fachhochschule Kiel	SUR-100 100 mW $< 5 \cdot 10^6$	a) 29.03.1966 b) 11.12.1997
16	TRIGA HD I Heidelberg Baden-Württemberg	Deutsches Krebsforschungszentrum	Swimming pool / TRIGA Mark I 0,25 MW $< 10^{13}$	a) 26.08.1966 b) 31.03.1977
17	SNEAK Eggenstein-Leopoldshafen Baden-Württemberg	Karlsruher Institut für Technologie	Homogeneous reactor 1 kW $< 7 \cdot 10^6$	a) 15.12.1966 b) 11/1985
18	ADIBKA (L77A) Jülich Nordrhein-Westfalen	Forschungszentrum Jülich	Homogeneous reactor 100 W $< 2{,}8 \cdot 10^8$	a) 18.03.1967 b) 30.10.1972
19	AEG Nullenergie Reaktor Karlstein Bayern	Kraftwerk Union	Tank type / Critical assembly 100 W $< 10^8$	a) 6/1967 b) 1973
20	SUR-HB Bremen	Hochschule Bremen	SUR-100 100 mW $< 5 \cdot 10^6$	a) 10.10.1967 b) 17.06.1993
21	NS OTTO HAHN Geesthacht Schleswig-Holstein	GKSS-Forschungszentrum Geesthacht	PWR ship reactor 38 MW $< 2{,}8 \cdot 10^{13}$	a) 26.08.1968 b) 22.03.1979
22	RAKE Rossendorf Sachsen	Verein für Kernforschungs-technik und Analytik Rossendorf (VKTA)	Tank type / Critical assembly 10 W $< 1 \cdot 10^8$	a) 03.10.1969 b) 26.11.1991

Appendix 2-3 Research reactors, completely dismantled

	Decommissioned or dismantled research reactors Site	Licensee	Reactor type therm. output th. n-flow [$cm^{-2}s^{-1}$]	a) First criticality b) Shutdown
23	KEITER Jülich Nordrhein-Westfalen	Forschungszentrum Jülich	Critical assembly 1 W $< 2{\cdot}10^{7}$	a) 15.06.1971 b) 1982
24	FRH Hannover Niedersachsen	Medizinische Hochschule Hannover	Swimming pool / TRIGA Mark I 0,25 MW $< 8{,}5{\cdot}10^{12}$	a) 31.01.1973 b) 18.12.1996
25	KAHTER Jülich Nordrhein-Westfalen	Forschungszentrum Jülich	Critical assembly 100 W $< 2{,}2{\cdot}10^{8}$	a) 02.07.1973 b) 03.02.1984
26	TRIGA HD II Heidelberg Baden-Württemberg	Deutsches Krebsforschungszentrum	Swimming pool / TRIGA Mark I 0,25 MW $< 10^{13}$	a) 28.02.1978 b) 30.11.1999
27	ZLFR Zittau Sachsen	Hochschule Zittau/Görlitz Fachbereich Maschinenwesen	Tank type/WWR-M 10 W $< 2{\cdot}10^{8}$	a) 25.05.1979 b) 24.03.2005
28	FRF 2 Frankfurt Hessen	Johann Wolfgang Goethe Universität Frankfurt	modified TRIGA 1 MW $< 3{\cdot}10^{13}$	a) no criticality b) construction since 1973, no operation, project stopped

Appendix 3 Design basis accidents and beyond design basis accidents, PWR and BWR

Level 3, design basis accidents — PWR

3-1 Transients

- Reactivity accident due to withdrawal of the most effective control rod or control rod group during start-up
- Loss of main heat sink caused by failure to open of the main steam bypass valve after turbine trip
- Loss of main feedwater supply
- Loss of auxiliary station supply (emergency power situation)
- Leakage in main steam piping up to 0.1F if manufactured in rupture preclusion quality, otherwise 2F

(F: open cross section of the pipe)

3-2 Loss of coolant accidents

Leakage sizes to be considered for typical locations in the primary coolant pressure boundary:

- Leak cross section < 120 cm^2 for
  - overpressure protection devices stuck-open
  - rupture of connecting pipes
  - leakage at branch-off locations, penetrations or seals
  - leakage through open cracks
  - double-ended rupture of a steam generator tube
- Leak size 0.1F in the primary coolant line if manufactured in rupture preclusion quality, otherwise up to 2F

3-3 Radiologically representative accidents

- Loss of coolant with
  - leak size 2F for an instrumentation pipe in the annulus, assumed open for 30 minutes after rupture
  - leak size 2F for steam generator tube rupture and simultaneous leak in the main steam line
  - behind the isolation valve, considering closing times of the isolation valve
  - leak size 0.1F if manufactured in rupture preclusion quality, otherwise up to 2F
- Fuel element handling accidents
  - damage of all fuel rods at the outside of the fuel element
- Failure of auxiliary systems
  - pipe rupture in the off-gas treatment system
  - failure of the liquid waste evaporator in the coolant treatment system

3-4 Internal impacts

- Flooding due to leakage of pipes outside the primary coolant boundary, up to 0.1F if manufactured in rupture preclusion quality, otherwise up to 2F
- Other internal flooding (e.g. leakage of auxiliary service water pipes)
- Plant-internal fires
- Fragments with high kinetic energy resulting from component failure (e.g. turbine blade failure)

3-5 External impacts

- Site-specific events caused by nature
  (earthquake and weather condition, such as lightning, flooding, wind, ice and snow)

Level 4, beyond design basis accidents — PWR

4-1 Specific, very rare events

- ATWS
- Site-specific, man-made external impacts (specific emergency situations)

4-2 Plant condition due to unavailability of activated safety equipment (emergencies)

- Loss of steam generator feed, with a trend to a total dry-out of the secondary side
- Loss of coolant from a small leak, with a trend to increase the primary coolant pressure beyond the feed pressure of the high pressure injection pumps
- Double-ended rupture of a steam generator tube and increasing main steam pressure, with a trend to open the main steam safety valves
- Loss of three-phase current supply - unless backed by batteries - for up to 2 hours
- Global long-term increase of containment pressure, with a trend to exceed the design pressure limit
- Increase of hydrogen concentration in the containment, with a trend to reach the ignition point

Level 3, design basis accidents — BWR

3-1 Transients

- Reactivity accidents
  - limited failure of the most effective control rod
  - uncontrolled withdrawal of control rods during start-up
- Loss of main heat sink due to erroneous closing of the main steam containment penetration valves
- Loss of the main feedwater supply
- Loss of auxiliary station supply (emergency power situation)

3-2 Loss of coolant accidents

Leakage sizes to be considered for typical locations in the coolant pressure boundary:

- Leak cross section < 80 cm² for leaks through open cracks in the lower plenum of the reactor pressure vessel, in between the control rod drives
- Leak size < 0.1F in pipes if manufactured in rupture preclusion quality, otherwise up to 2F (F: open cross section of the pipe)

3-3 Radiologically representative accidents

- Loss of coolant with
  - leak size 2F for an instrumentation pipe with reactor coolant in the reactor building,
  - assumed open for 30 minutes after rupture
  - leak size 0.1F for a residual heat removal train in the reactor building if manufactured
  - in rupture preclusion quality, otherwise 1F, considering closing times of the isolation valve
  - leak size 0,1F if manufactured in rupture preclusion quality, otherwise up to 2F
  - Leak cross section 80 cm² for leaks through open cracks in the lower plenum of the reactor pressure vessel, in between the control rod drives
- Fuel element handling accidents
  - damage of all fuel rods at the outside of the fuel element
- Failure of auxiliary systems
  - pipe rupture in the off-gas treatment system
  - failure of the liquid waste evaporator in the coolant treatment system

3-4 Internal impacts

- Flooding due to leakage of pipes outside the reactor coolant boundary, up to 0.1F if manufactured in rupture preclusion quality, otherwise up to 2F
- Other internal flooding (e.g. leakage of auxiliary service water pipes)
- Plant-internal fires
- Fragments with high kinetic energy resulting from component failure (e.g. turbine blade failure)

3-5 External impacts

- Site-specific events caused by nature (earthquakes and weather condition, such as lightning, flooding, wind, ice and snow)

Level 4, beyond design basis accidents — BWR

4-1 Specific, very rare events

- ATWS
- site-specific, man-made external impacts (specific emergency situations)

4-2 Plant conditions due to unavailability of activated safety equipment (emergencies)

- Loss of coolant with subsequent overfeeding of a main steam pipe and the possibility of water hammer outside the penetration isolation
- Transients with a trend to decrease the coolant level within the reactor pressure vessel to the bottom of the core
- Loss of three-phase current supply - unless backed by batteries - for up to 2 hours
- Global long-term increase of containment pressure, with a trend to exceed the design pressure limit
- Increase of hydrogen concentration in the containment, with a trend to reach the ignition point

Appendix 4 Design characteristics important to safety, PWR and BWR

1. Reactor coolant pressure boundary **PWR**

Design characteristics	Construction line 1	Construction line 2	Construction line 3	Construction line 4
Number of loops	2 or 4	3 or 4	4	4
Suitability of the components for non-destructive testing	Yes, with minor restrictions		Yes	
Components				
- Seamless forged rings for vessels	Reactor pressure vessel, steam generators (primary side only)		Reactor pressure vessel, steam generators, pressuriser	
- Seamless pipes	Main coolant line with minor restrictions		Main coolant line	
Materials				
- Ageing-resistant ferritic fine-grained structural steels with stabilised austenitic cladding	All components and pipes with nominal diameter > 400 mm			Like construction lines 1-3, but with optimised qualities
- Ageing-resistant stabilised austenitic steels	All pipes with nominal diameter < 400 mm and component internals			
- Corrosion-resistant steam generator tube material (Incoloy 800)	Yes (after exchange of steam generators in one plant)	Yes		
Application of the rupture preclusion concept	Post-commissioning qualification		Prior to commissioning	From the start of planning
Reduction of embrittlement from neutron radiation exposure	Use of dummy fuel elements and special fuel element management	Optimised welding material and enlargement of water gap in the reactor pressure vessel to reduce neutron fluence		

1. Reactor coolant pressure boundary BWR

Design characteristics	Construction line 69	Construction line 72
Re-circulation pumps integrated in the reactor pressure vessel	8 to 10	8
Suitability of the components for non-destructive testing	Yes, with minor restrictions	Yes
Components		
- Seamless forged rings for reactor pressure vessels	No	Yes, except: closure head, bottom head
- Seamless pipes	Yes, after replacement of pipes	Yes
Materials		
- Ageing-resistant ferritic fine-grained structural steels	Reactor pressure vessel, main-steam and feedwater pipes	
- Ageing-resistant stabilised austenitic steels	Pipes *), partly backfitted by replacements, in addition reactor pressure vessel internals and cladding	
Application of the break preclusion concept	Post-qualification partly through pipe replacement	Prior to planning; under review **)
Reduction of embrittlement from neutron radiation exposure	Special fuel element management (low leakage loading)	

*) for KRB II: only stabilised austenitic pipes are used
**) for KRB II: the break preclusion concept was approved by the competent authority with a modification licence

2. Emergency core cooling PWR

Design characteristics	Construction line 1	Construction line 2	Construction line 3	Construction line 4
Number of emergency core cooling trains/capacity	4 trains of at least 50% each			
Pump head of high-pressure pumps	Approximately 110 bar			
Secondary circuit shutdown in case of small leaks	Manually or fully automatic	Automatic partial shutdown or fully automatic	Fully automatic	
Number of borated water flooding tanks	3 or 5	4, in some cases twin tanks or 4 flooding pools		
Pump head of low-pressure injection pumps	1 plant 8 bar 1 plant 18 bar	Approximately 10 bar		
Accumulators (injection pressure)	1 per loop (26 bar); 1 plant without accumulators	1 or 2 per loop (25 bar)	2 per loop (25 bar)	
Sump pipe before outer penetration isolation valve	Single pipe (1 plant without sump suction pipe)	Guard pipe construction, some with leakage monitoring	Guard pipe construction with leakage monitoring	
Place of installation of the active emergency core cooling systems	Separate building, reactor building or annulus	Annulus		

2. Emergency core cooling BWR

Design characteristics	Construction line 69	Construction line 72
Number of trains of the high-pressure safety injection system (capacity)	1 train (steam turbine, up to 50 bar main steam pressure, approx. 300 kg/s)	3 trains (electric pumps, 3 x 70 kg/s)
Diversified high-pressure safety injection system	1 train (electric pump approx. 40 kg/s)	No
Pressure relief	7 to 11 safety and pressure relief valves, additionally 3 to 6 motorised pressure relief valves	11 safety and pressure relief valves, additionally 3 motorised pressure relief valves
Intermediate-pressure injection system	No	1 train (additional independent RHR system; electric pump, 40 bar)
Number of low-pressure emergency core cooling trains/capacity	4 trains of 50% each	3 trains of 100% each
Low-pressure safety system with diversified injection	1 x 100% core flooding system	No
Backfeed from containment sump	Yes, via active systems	Yes, via passive systems with 4 overflow pipes
Place of installation of the emergency core cooling systems	In separate rooms of the reactor building	In separate rooms of the reactor building, intermediate-pressure system in a bunkered building

3. Containment vessel PWR

Design characteristics	Construction line 1	Construction line 2	Construction line 3	Construction line 4
Type	Spherical steel vessel with surrounding concrete enclosure, annular gap and constant internal subatmospheric pressure			
Design pressure (overpressure)	1 plant 2.99 bar 1 plant 3.78 bar	4.71 bar	5.3 bar	5.3 bar
Design temperature	1 plant 125°C 1 plant 135°C	135°C	145°C	145°C
Material of steel vessel (main structure)	BH36KA; HSB50S	FB70WS; FG47WS; BHW33	FG51WS; 15 MnNi 63; Aldur 50/65D	15 MnNi 63
Wall thickness of steel vessel in the spherical region remote from discontinuities	Up to 25 mm	Up to 29 mm	Up to 38 mm	38 mm
Airlocks:				
- Equipment airlock	Single or double seals without evacuation	Double seals with evacuation		
- Personnel airlock	Single or double seals without evacuation	Double seals with evacuation		
- Emergency airlock	One with single seal	One with double seals and evacuation	Two with double seals and evacuation	
Penetrations:				
- Main steam line	One isolation valve outside of containment			
- Feedwater line	One isolation valve each inside and outside of containment			
- Emergency core cooling and auxiliary systems	With a few exceptions, one isolation valve each inside and outside of containment			One isolation valve each inside and outside of containment
- Ventilation systems	One isolation valve each inside and outside of containment			

3. Containment vessel BWR

Design characteristics	Construction line 69	Construction line 72
Type	Spherical steel vessel with pressure suppression pool located in the thorus	Cylindrical pre-stressed concrete shell with annular pressure suppression pool
Design pressure (overpressure)	Up to 3.5 bar	3.3 bar
Design temperature	Approximately 150°C	
Material of steel vessel (main structure)	WB25; Aldur50D, BHW25	TTSTE29
Wall thickness of steel vessel outside the concrete support	Depending on geometry and design: 18 mm to 50 mm, 18 mm to 65 mm, 20 mm to 70 mm, 25 mm to 70 mm	8 mm steel liner
Number of pipes in the pressure suppression pool	Depending on the plant: 58, 62, 76 or 90	63
Immersion depth of pipes in the pressure suppression pool	2.0 or 2.8 m	4.0 m
Inertisation of the air in the pressure suppression pool	Yes	Yes
Inertisation of the drywell	Yes	No
Airlocks:	In all cases double seals with evacuation	
- Equipment airlock	None	
- Personnel airlock	Leading to control rod drive chamber, for personnel and for equipment transports	
- Emergency airlock	One from control rod drive chamber	Two, one from control rod drive chamber and one above pressure suppression pool
Penetrations:		
- Main steam line/ Feedwater line	One isolation valve each inside and outside of containment	
- Emergency core cooling and auxiliary systems	Emergency core cooling system in the area of the pressure suppression pool and several small pipes with two isolation valves outside of containment, otherwise one isolation valve each inside and outside of containment	
- Ventilation systems	Two isolation valves outside of containment	

4. Limitations and Safety Actuation Systems PWR

4.1 Limitations

Design characteristics	Construction line 1	Construction line 2	Construction line 3	Construction line 4
Reactor power limitation	1 plant yes, 1 plant no	Yes		
Control rod movement limitation	Yes (monitoring of shut-down reactivity)			
Limitations of coolant pressure, coolant mass and temperature gradient	Coolant pressure	Partially	Yes	

4.2 Safety actuation systems

Design characteristics	Construction line 1	Construction line 2	Construction line 3	Construction line 4
Actuation criteria derived from accident analysis	Largely, yes	Yes		
Different physical actuation criteria for reactor protection system	Yes or higher-grade redundancy	Yes or diverse actuation channels		
Failure combinations	Random failure, systematic failure, consequential failures, non-availability due to maintenance			
Testing of reactor protection system is possible during power operation	Yes, largely by automatic self-monitoring (of functional readiness)			
Actuation of protection systems	Apart from a few exceptions, all actions are performed automatically, and manual actions are not required within the first 30 min after the onset of an accident.			

4. Limitations and safety actuation systems **BWR**

4.1 Limitations

Design characteristics	Construction line 69	Construction line 72
Fixed reactor power limitation	Yes, speed reduction of forced-circulation pumps	
Variable reactor power limitation	Yes, control rod withdrawal interlock start-up interlock of forced-circulation pumps	
Local power limitation	Yes, control rod withdrawal interlock	Yes, control rod withdrawal interlock and speed reduction of forced-circulation pumps

4.2 Safety actuation systems

Design characteristics	Construction line 69	Construction line 72
Actuation criteria derived from accident analysis	Largely, yes	Yes
Different physical actuation criteria for reactor protection system	Yes, or higher level of redundancy	Yes, or diversified actuation channels
Failure combinations	Random failure, systematic failure, consequential failures, non-availability due to maintenance	
Testing of reactor protection system is possible during power operation	Yes, largely by automatic self-monitoring (of functional readiness)	
Actuation of protection systems	Apart from a few exceptions, all actions are performed automatically, and manual actions are not required within the first 30 min after the onset of an accident.	

5. Electric power supply **PWR**

Design characteristics	Construction line 1	Construction line 2	Construction line 3	Construction line 4
Number of independent off-site power supplies	At least 3			
Generator circuit breaker	Yes			
Auxiliary station supply in the case of off-site power loss	Yes, load rejection to auxiliary station supply			
Emergency power supply	2 trains with 3 diesels altogether, or 4 trains with 1 diesel each	4 trains with 1 diesel each		
Additional emergency power supply for the control of external impacts	2 trains	1 - 2 trains, unit support system at one double-unit plant	4 trains with 1 diesel each	
Uninterruptible DC power supply	2 x 2 trains	4 trains (except for 1 plant with 2 x 4 trains)	3 x 4 trains	
Protected DC power supply	2 hours			
Separation of trains	Intermeshed emergency power supply, physical separation of the emergency power supply grids	Partially intermeshed emergency power supply, physical separation of the emergency power supply grids	Largely non-intermeshed emergency power supply, physical separation of the emergency power supply grids	

5. Electric power supply BWR

Design characteristics	Construction line 69	Construction line 72
Number of independent off-site power supplies	At least 3	
Generator circuit breaker	Yes	
Auxiliary station supply in the case of off-site power loss	Yes, load rejection to auxiliary station supply	
Emergency power supply	2 - 6 trains with at least 1 diesel each	5 trains with 1 diesel each
Additional emergency power supply for the control of external impacts	2 - 3 trains with 1 diesel each	1 - 3 trains with 1 diesel each
Uninterruptible DC power supply	2 x 2 trains or 4 x 2 trains	2 x 3 trains
Protected DC power supply	At least 2 hours	
Separation of trains	Partially intermeshed emergency power supply, physical separation of the emergency power supply grids	Largely non-intermeshed emergency power supply, physical separation of the emergency power supply grids

6. Protection against external impacts **PWR**

Design characteristics	Construction line 1	Construction line 2	Construction line 3	Construction line 4
Earthquake	Design of components important to safety in accordance with site-specific load assumptions			
Aircraft crash and pressure waves from explosions	Not considered in the design, later risk assessment, separate emergency systems	Different designs, separate emergency systems	Design in accordance with the nuclear safety regulations (→ Article 17 (i)), emergency systems integrated in the safety system	

6. Protection against external impacts **BWR**

Design characteristics	Construction line 69	Construction line 72
Earthquake	Design of components important to safety in accordance with site-specific load assumptions	
Aircraft crash and pressure waves from explosions	Different designs, up to status of construction line 72, emergency systems separate, or integrated in the safety system	Design in accordance with the nuclear safety regulations (→ Article 17 (i)), emergency systems integrated in the safety system

Appendix 5 Reference list of nuclear safety regulations

Selection of regulations concerning nuclear power plants;
structure and order of the references are largely in accordance with the “Handbuch Reaktorsicherheit und Strahlenschutz" (*Handbook on Nuclear Safety and Radiation Protection*) http://www.bfs.de/de/bfs/recht/rsh

Contents

1 Legislation

1A National legislation on nuclear safety and radiation protection

1A-1 **Grundgesetz** für die Bundesrepublik Deutschland vom 23. Mai 1949 (BGBl.I 1949, Nr. 1, S. 1), geändert bzgl. Kernenergie durch Gesetz vom 23. Dezember 1959, betreffend Artikel 74 Nr. 11a und 87c (BGBl.I 1959, Nr. 56, S. 813), erneut geändert bzgl. Kernenergie durch Gesetz vom 28. August 2006 betreffend Artikel 73, 74 und 87c (BGBl.I 2006, Nr. 41, S. 2034)

1A-2.1 **Organisationserlass** des Bundeskanzlers vom 5. Juni 1986 (BGBl.I 1986, Nr. 25, S. 864) zur Bildung des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit

1A-2.2 **Organisationserlass** des Bundeskanzlers vom 16. Juli 1999 (BGBl.I 1999, Nr. 40, S. 1723)
Hinweis: Zuständigkeit für Bereich Strahlenschutz in der Radiologie an BMU übertragen

1A-2.3 Gesetz über die Errichtung eines **Bundesamtes für Strahlenschutz** - BAStrlSchG - vom 9. Oktober 1989 (BGBl.I 1989, Nr. 47, S. 1830), zuletzt geändert durch Artikel 2 des Gesetzes vom 3. Mai 2000 (BGBl.I 2000, Nr. 20, S. 636)

1A-3 Gesetz über die friedliche Verwendung der Kernenergie und den Schutz gegen ihre Gefahren (**Atomgesetz** - AtG) vom 23. Dezember 1959, Neufassung vom 15. Juli 1985 (BGBl.I 1985, Nr. 41, S. 1565), zuletzt geändert durch Artikel 1 des Gesetzes vom 17. März 2009 (BGBl.I 2009, Nr. 15, S. 556)

- **Hinweis:** geändert durch Artikel 1 des Gesetzes vom 29. August 2008 (BGBl.I 2008, Nr. 40, S. 1793), diese Änderung tritt erst in Kraft, wenn das Protokoll vom 12. Februar 2004 zur Änderung des Übereinkommens vom 29. Juli 1960 über die Haftung gegenüber Dritten auf dem Gebiet der Kernenergie in der Fassung des Zusatzprotokolls vom 28. Januar 1964 und des Protokolls vom 16. November 1982 nach seinem Artikel 20 in Kraft tritt (vgl. 1E-5.1 Pariser Übereinkommen)

1A-4 **Fortgeltendes Recht der Deutschen Demokratischen Republik** aufgrund von Artikel 9 Abs. 2 in Verbindung mit Anlage II Kapitel XII Abschnitt III Nr. 2 und 3 des Einigungsvertrages vom 31. August 1990 in Verbindung mit Artikel 1 des Gesetzes zum Einigungsvertrag vom 23. September 1990 (BGBl.II 1990, Nr. 35, S. 885 und 1226), soweit dabei radioaktive Stoffe, insbesondere Radonfolgeprodukte, anwesend sind:

- **Verordnung über die Gewährleistung von Atomsicherheit und Strahlenschutz** – AtStrlSV - vom 11. Oktober 1984 (GBl. (DDR) I 1984, Nr. 30, S. 341) und **Durchführungsbestimmung zur Verordnung über die Gewährleistung von Atomsicherheit und Strahlenschutz** – AtStrlSVDBest - vom 11. Oktober 1984 (GBl. (DDR) I 1984, Nr. 30, S. 348, berichtigt GBl. (DDR) I 1987, Nr. 18, S. 196)
- **Anordnung zur Gewährleistung des Strahlenschutzes bei Halden und industriellen Absetzanlagen und bei Verwendung darin abgelagerter Materialien** – StrSAblAnO - vom 17. November 1990 (GBl. (DDR) I 1990, Nr. 34, S. 347)

1A-5 Gesetz zum vorsorgenden Schutz der Bevölkerung gegen Strahlenbelastung (**Strahlenschutzvorsorgegesetz** - StrVG) vom 19. Dezember 1986 (BGBl.I 1986, Nr. 69, S. 2610), zuletzt geändert durch Artikel 1 des Gesetzes vom 8. April 2008 (BGBl.I 2008, Nr. 14, S. 686)

1A-8 Verordnung über den Schutz vor Schäden durch ionisierende Strahlen (**Strahlenschutzverordnung** - StrlSchV) vom 20. Juli 2001 (BGBl.I 2001, Nr. 38, S. 1714), zuletzt geändert durch Artikel 3 des Gesetzes vom 13. Dezember 2007 (BGBl.I 2007, Nr. 65, S. 2930), Dosiskoeffizienten in BAnz 2001, Nr. 16

- **Hinweis:** geändert durch Artikel 2 des Gesetzes vom 29. August 2008 (BGBl.I 2008, Nr. 40, S. 1793), diese Änderung tritt erst in Kraft, wenn das Protokoll vom 12. Februar 2004 zur Änderung des Übereinkommens vom 29. Juli 1960 über die Haftung gegenüber Dritten auf dem Gebiet der Kernenergie in der Fassung des Zusatzprotokolls vom 28. Januar 1964 und des Protokolls vom 16. November 1982 nach seinem Artikel 20 in Kraft tritt (vgl. 1E-5.1 Pariser Übereinkommen)

1A-10 Verordnung über das Verfahren bei der Genehmigung von Anlagen nach § 7 des Atomgesetzes (**Atomrechtliche Verfahrensverordnung** - AtVfV) vom 18. Februar 1977, Neufassung vom 3. Februar 1995 (BGBl.I 1995, Nr. 8, S. 180), zuletzt geändert durch Artikel 4 des Gesetzes vom 9. Dezember 2006 (BGBl.I 2006, Nr. 58, S. 2819)

1A-11 Verordnung über die Deckungsvorsorge nach dem Atomgesetz (**Atomrechtliche Deckungsvorsorge-Verordnung** - AtDeckV) vom 25. Januar 1977 (BGBl.I 1977, Nr. 8, S. 220), zuletzt geändert durch Artikel 9 Absatz 12 des Gesetzes vom 23. November 2007 (BGBl.I 2007, Nr. 59, S. 2631)

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 1982, Nr. 16, S. 562), zuletzt geändert durch Verordnung vom 6. Juli 2004 (BGBl.I 2004, Nr. 33, S. 1476)

1A-17 Verordnung über den kerntechnischen Sicherheitsbeauftragten und über die Meldungen von Störfällen und sonstigen Ereignissen (**Atomrechtliche Sicherheitsbeauftragten- und Meldeverordnung** - AtSMV) vom 14. Oktober 1992 (BGBl.I 1992, Nr. 48, S. 1766), zuletzt geändert durch Verordnung vom 18. Juni 2002 (BGBl.I 2002, Nr. 36, S. 1869)

- **Hinweis:** geändert durch Verordnung vom 8. Juni 2010 (BGBl.I 2010, Nr. 31, S. 755), diese Änderung tritt am 1. Oktober 2010 in Kraft

1A-18 Verordnung über die Verbringung radioaktiver Abfälle in das oder aus dem Bundesgebiet (**Atomrechtliche Abfallverbringungsverordnung** - AtAV) vom 30. April 2009 (BGBl.I 2009, Nr. 24, S. 1000)

1A-19 Verordnung für die Überprüfung der Zuverlässigkeit zum Schutz gegen Entwendung oder erhebliche Freisetzung radioaktiver Stoffe nach dem Atomgesetz (**Atomrechtliche Zuverlässigkeitsüberprüfungs-Verordnung** - AtZüV) vom 1. Juli 1999 (BGBl.I 1999, Nr. 35, S. 1525), zuletzt geändert durch Artikel 1 der Verordnung vom 22. Juni 2010 (BGBl.I 2010, Nr. 34, S. 825)

1A-20 Verordnung zur Abgabe von kaliumiodidhaltigen Arzneimitteln zur Iodblockade der Schilddrüse bei radiologischen Ereignissen (**Kaliumiodidverordnung** - KIV) vom 5. Juni 2003 (BGBl.I 2003, Nr. 25, S. 850), zuletzt geändert durch Artikel 70 des Gesetzes vom 21. Juni 2005 (BGBl.I 2005, Nr. 39, S. 1818)

1A-21 **Kostenverordnung zum Atomgesetz** - AtKostV - vom 17. Dezember 1981 (BGBl.I 1981, Nr. 56, S. 1457), zuletzt geändert durch Artikel 4 des Gesetzes vom 29. August 2008 (BGBl.I 2008, Nr. 40, S. 1793)

1A-22 Verordnung zur Festlegung einer Veränderungssperre zur Sicherung der Standorterkundung für eine Anlage zur Endlagerung radioaktiver Abfälle im Bereich des Salzstocks Gorleben (**Gorleben-Veränderungssperren-Verordnung** - Gorleben VSpV) vom 25. Juli 2005 (BAnz 2005, Nr. 153a)

1B Legal provisions also to be applied in nuclear safety and radiation protection

1B-1 **Verwaltungsverfahrensgesetz** - VwVfG - vom 25. Mai 1976 (BGBl.I 1976, Nr. 59, S. 1253), Neufassung vom 23. Januar 2003 (BGBl.I 2003, Nr. 4, S. 102), zuletzt geändert durch Artikel 2 Absatz 1 des Gesetzes vom 14. August 2009 (BGBl.I 2009, Nr. 54, S. 2827)

1B-2.1 **Umweltinformationsgesetz** - UIG - vom 22. Dezember 2004 (BGBl.I 2004, Nr. 73, S. 3704)

1B-2.2 **Umweltinformationskostenverordnung** - UIGKostV - vom 7. Dezember 1994 (BGBl.I 1994, Nr. 88, S. 3732), Neufassung vom 23. August 2001 (BGBl.I 2001, Nr. 45, S. 2247), zuletzt geändert durch Artikel 4 des Gesetzes vom 22. Dezember 2004 (BGBl.I 2004, Nr. 73, S. 3704)

1B-3 **Umweltverträglichkeitsprüfungsgesetz** - UVPG - vom 12. Februar 1990 (BGBl.I 1990, Nr. 6, S. 205), Neufassung vom 24. Februar 2010 (BGBl.I 2010, Nr. 7, S. 94)

1B-4 **Umweltauditgesetz** - UAG - vom 7. Dezember 1995 (BGBl.I 1995, Nr. 61, S. 1591), Neufassung vom 4. September 2002 (BGBl.I 2002, Nr. 64, S. 3490) zuletzt geändert durch Artikel 11 des Gesetzes vom 17. März 2008 (BGBl.I 2008, Nr. 10, S. 399)

1B-10 **Umwelthaftungsgesetz** - UmweltHG - vom 10. Dezember 1990 (BGBl.I 1990, Nr. 67, S. 2634), zuletzt geändert durch Artikel 9 Absatz 5 des Gesetzes vom 23. November 2007 (BGBl.I 2007, Nr. 59, S. 2631)

1B-11 **Strafgesetzbuch** - StGB - vom 15. Mai 1871 (RGBl. S. 127), Neufassung vom 13. November 1998 (BGBl.I 1998, Nr. 75, S. 3322), zuletzt geändert durch Artikel 3 des Gesetzes vom 2. Oktober 2009 (BGBl.I 2009, Nr. 66, S. 3214)

1B-14 **Raumordnungsgesetz** - ROG - vom 18. August 1997 (BGBl.I 1997, Nr. 59, S. 2081), Neufassung durch Gesetz vom 22. Dezember 2008 (BGBl.I 2008, Nr. 65, S. 2986), zuletzt geändert durch Artikel 9 des Gesetzes vom 31. Juli 2009 (BGBl.I 2009, Nr. 51, S. 2585)

1B-16 Gesetz zum Schutz vor schädlichen Umwelteinwirkungen durch Luftverunreinigungen, Geräusche, Erschütterungen und ähnliche Vorgänge (**Bundes-Immissionsschutzgesetz** - BImSchG) vom 26. September 2002 (BGBl.I 2002, Nr. 71, S. 3830), zuletzt geändert durch Artikel 2 des Gesetzes vom 11. August 2009 (BGBl.I 2009, Nr. 53, S. 2723); mit diversen Verordnungen

1B-24 **Kreislaufwirtschafts- und Abfallgesetz** - KrW-/AbfG - vom 27. August 1994 (BGBl.I 1994, Nr. 66, S. 2705), zuletzt geändert durch Artikel 3 des Gesetzes vom 11. August 2009 (BGBl.I 2009, Nr. 53, S. 2723)

1B-27 **Wasserhaushaltsgesetz** - WHG - vom 31. Juli 2009 (BGBl.I 2009, Nr. 51, S. 2585)

1B-29 Gesetz über Naturschutz und Landschaftspflege (**Bundesnaturschutzgesetz** – BNatSchG) vom 29. Juli 2009 (BGBl.I 2009, Nr. 51, S. 2542)

1B-31 Verordnung zum Schutz vor Gefahrstoffen (**Gefahrstoffverordnung** - GefStoffV) vom 23. Dezember 2004 (BGBl.I 2004, Nr. 74, S. 3759), zuletzt geändert durch Artikel 2 der Verordnung vom 18. Dezember 2008 (BGBl.I 2008, Nr. 62, S. 2768)

1B-32 Verordnung über die Qualität von Wasser für den menschlichen Gebrauch (**Trinkwasserverordnung –** TrinkwV 2001) vom 21. Mai 2001 (BGBl.I 2001, Nr. 24, S. 959), zuletzt geändert durch Artikel 363 der Verordnung vom 31. Oktober 2006 (BGBl.I 2006, Nr. 50, S. 2407)

1B-33 Gesetz über technische Arbeitsmittel und Verbrauchsprodukte (**Geräte- und Produktsicherheitsgesetz** - GPSG) vom 6. Januar 2004 (BGBl.I 2004, Nr. 1, S. 2), zuletzt geändert durch Artikel 3 Absatz 33 des Gesetzes vom 7. Juli 2005 (BGBl.I 2005, Nr. 42, S. 1970)

- 14. GPSGV- **Druckgeräteverordnung** vom 27. September 2002 (BGBl.I 2002, Nr. 70, S. 3777), zuletzt geändert durch Artikel 21 des Gesetzes vom 6. Januar 2004 (BGBl.I 2004, Nr. 1, S. 2)
  Hinweis: "Geräte, die speziell zur Verwendung in kerntechnischen Anlagen entwickelt wurden und deren Ausfall zu einer Freisetzung von Radioaktivität führen kann" sind hier ausgenommen

1B-34 Verordnung über Sicherheit und Gesundheitsschutz bei der Bereitstellung von Arbeitsmitteln und deren Benutzung bei der Arbeit, über Sicherheit beim Betrieb überwachungsbedürftiger Anlagen und über die Organisation des betrieblichen Arbeitsschutzes (**Betriebsicherheitsverordnung** - BetrSichV) vom 27. September 2002 (BGBl.I 2002, Nr. 70, S. 3777), zuletzt geändert durch Artikel 8 der Verordnung vom 18. Dezember 2008 (BGBl.I 2008, Nr. 62, S. 2768)
Hinweis: es bleiben "atomrechtliche Vorschriften des Bundes und der Länder unberührt, soweit in ihnen weitergehende oder andere Anforderungen gestellt oder zugelassen werden."

1B-37.1 **Unfallverhütungsvorschrift Kernkraftwerke** (BGV C16, bisher VBG30) vom 1. Januar 1987 in der Fassung vom 1. Januar 1997 und **Durchführungsanweisung zur Unfallverhütungsvorschrift Kernkraftwerk** (DA zu BGV C16 VGB30) vom 1. Januar 1987 (Berufgenossenschaftliches Vorschriften- und Regelwerk)

1B-38 Gesetz über Betriebsärzte, Sicherheitsingenieure und andere **Fachkräfte für Arbeitssicherheit** - ASiG - vom 12. Dezember 1973 (BGBl.I 1973, Nr. 105, S. 1885), zuletzt geändert durch Artikel 226 der Verordnung vom 31. Oktober 2006 (BGBl.I 2006, Nr. 50, S. 2407)

1B-39 **Lebensmittel-, Bedarfsgegenstände- und Futtermittelgesetzbuch** - LFGB - vom 1. September 2005 (BGBl.I 2005, Nr. 55, S. 2618), Neufassung vom 24. Juli 2009 (BGBl.I 2009, Nr. 47, S. 2205), geändert durch Artikel 1 des Gesetzes vom 3. August 2009 (BGBl.I 2009, Nr. 52, S. 2630)

1B-40 Gesetz über den Verkehr mit Lebensmitteln, Tabakerzeugnissen, kosmetischen Mitteln und sonstigen Bedarfsgegenständen (**Lebensmittel- und Bedarfsgegenständegesetz** - LMG 1974) vom 15. August 1974 (BGBl.I 1975, Nr. 17, S. 2652), Neufassung und Umbenennung in „**Vorläufiges Tabakgesetz**" vom 9. September 1997 (BGBl.I 1997, Nr. 63, S. 2296), zuletzt geändert durch Artikel 1 des Gesetzes vom 6. Juli 2010 (BGBl.I 2010, Nr. 35, S. 848)

1B-41 **Bedarfsgegenständeverordnung** - BedGgstV - vom 10. April 1992 (BGBl.I 1992, Nr. 20, S. 866), Neufassung vom 23. Dezember 1997 (BGBl.I 1998, Nr. 1, S. 5), zuletzt geändert durch Verordnung vom 23. September 2009 (BGBl.I 2009, Nr. 62, S. 3130)

1B-42.1 **Informationsfreiheitsgesetz** - IFG - vom 5. September 2005 (BGBl.I 2005, Nr. 57, S. 2722)

1B-42.2 **Informationsgebührenverordnung** - IFGGebV - vom 2. Januar 2006 (BGBl.I 2006, Nr. 1, S. 6)

1B-44 Gesetz über ergänzende Vorschriften zu Rechtsbehelfen in Umweltangelegenheiten nach der EG-Richtlinie 2003/35/EG (**Umwelt-Rechtsbehelfsgesetz** - UmwRG) vom 7. Dezember 2006 (BGBl.I 2006, Nr. 58, S. 2816), zuletzt geändert durch Artikel 15 des Gesetzes vom 31. Juli 2009 (BGBl.I 2009, Nr. 51, S. 2585)

1B-45 Gesetz über den Zivilschutz und die Katastrophenhilfe des Bundes (**Zivilschutz- und Katastrophenhilfegesetz** - ZSKG) vom 25. März 1997 (BGBl.I 1997, Nr. 21, S. 726), zuletzt geändert durch Artikel 2 des Gesetzes vom 29. Juli 2009 (BGBl.I 2009, Nr. 49, S. 2350)

1B-46.1 Verordnung über die **Berufsausbildung zur Fachkraft für Schutz und Sicherheit** -SchSiServAusbV- vom 21. Mai 2008 (BGBl.I 2008, Nr. 21, S. 932)
Hinweis: Verordnung nebst Rahmenlehrplan veröffentlicht in BAnz. 2008, Nr. 130a

1B-46.2 Verordnung über die **Berufsausbildung zur Servicekraft für Schutz und Sicherheit** – SchSiServAusbV - vom 21. Mai 2008 (BGBl.I 2008, Nr. 21, S. 940)
Hinweis: Verordnung nebst Rahmenlehrplan veröffentlicht in BAnz. 2008, Nr. 128a

1B-46.3 Verordnung über die **Prüfung zum** anerkannten Abschluss **Geprüfter Meister/Geprüfte Meisterin für Schutz und Sicherheit** - SchSiMeistPrV - vom 26. März 2003 (BGBl.I 2003, Nr. 11, S. 433), zuletzt geändert durch Artikel 12 der Verordnung vom 25. August 2009 (BGBl.I 2009, Nr. 57, S. 2960)

1E Multilateral agreements in the field of nuclear safety and radiation protection including their national implementing provisions

1E-1 General provisions

1E-1.1 Übereinkommen über die Umweltverträglichkeitsprüfung im grenzüberschreitenden Rahmen - **Espoo-Konvention** (Convention on the Environmental Impact Assessment in a Transboundary Context - EIA) vom 25. Februar 1991, in Kraft seit 10. September 1997
1. Änderung der Espoo-Konvention vom 27. Februar 2001, noch nicht in Kraft
2. Änderung der Espoo-Konvention vom 4. Juni 2004, noch nicht in Kraft
Gesetz zur Espoo-Konvention und der 1. Änderung (**Espoo-Vertragsgesetz**) vom 7. Juni 2002 (BGBl.II 2002, Nr. 22, S. 1406)
Espoo-Konvention in Kraft für Deutschland seit 6. November 2002
Gesetz zur 2. Änderung (**Zweites Espoo-Vertragsgesetz**) vom 17. März 2006 (BGBl.II 2006, Nr. 7, S. 224)

1E-1.2 Protokoll über die strategische Umweltprüfung zum Übereinkommen über die Umweltverträglichkeitsprüfung im grenzüberschreitenden Rahmen (Protocol on Strategic Environmental Assessment - **SEA-Protocol**) vom 21. Mai 2003, in Kraft seit 11. Juli 2010
Gesetz dazu vom 3. Juni 2006 (BGBl.II 2006, Nr. 15, S. 497)

1E-1.3 Konvention über den Zugang zu Informationen, die Öffentlichkeitsbeteiligung an Entscheidungsverfahren und den Zugang zu Gerichten in Umweltangelegenheiten - **Aarhus-Konvention** (Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters) vom 25. Juni 1998, in Kraft seit 30. Oktober 2001
von Deutschland gezeichnet am 21. Dezember 1998
Gesetz dazu (**Informationsfreiheitsgesetz**) vom 5. September 2005 (BGBl.I 2005, Nr. 57, S. 2722)
Gesetz dazu (**Vertragsgesetz**) vom 9. Dezember 2006 (BGBl.II 2006, Nr. 31, S. 1251)
Protokoll zu Registern über die Freisetzung und Verbringung von Schadstoffen zur Aarhus-Konvention (Protocol on Pollutant Release and Transfer Registers to the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters PRTR) vom 27. Mai 2003, in Kraft seit 8. Oktiober 2009
Ergänzung zur Aarhus-Konvention (Amendment to the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters) vom 27. Mai 2005, noch nicht in Kraft
Gesetz dazu (Erstes Aarhus-Änderungs-Übereinkommen) vom 17. Juli 2009 (BGBl.II 2009, Nr. 25, S. 794)

1E-2 Nuclear safety and radiation protection

1E-2.1 **Übereinkommen über nukleare Sicherheit** (Convention on Nuclear Safety - CNS, INFCIRC/449) vom 20. September 1994, in Kraft seit 24. Oktober 1996
Gesetz dazu vom 7. Januar 1997 (BGBl.II 1997, Nr. 2, S. 130)
in Kraft für Deutschland seit 20. April 1997 (BGBl.II 1997, Nr. 14, S. 796)

1E-2.2 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 dazu vom 24. April 1990 (BGBl.II 1990, Nr. 15, S. 326), zuletzt geändert durch Artikel 4 Absatz 4 des Gesetzes vom 26. Januar 1998 (BGBl.I 1998, Nr. 6, S. 164)
in Kraft für Deutschland seit 6. Oktober 1991 (BGBl.II 1995, Nr. 11, S. 299)
Ergänzung vom 6. September 2005 und Umbenennung in Übereinkommen über den physischen Schutz von Kernmaterial und Kernanlagen (Convention on the Physical Protection of Nuclear Material and Nuclear Facilities), noch nicht in Kraft
Gesetz dazu vom 6. Juni 2008 (BGBl.I 2008, Nr. 14, S. 574)

1E-2.3 Übereinkommen zur **Errichtung einer Sicherheitskontrolle auf dem Gebiet der Kernenergie** nebst Protokoll über das auf dem Gebiet der Kernenergie errichtete Gericht (Convention on the Establishment of a Security Control in the Field of Nuclear Energy) vom 20. Dezember 1957
Gesetz dazu vom 26. Mai 1959 (BGBl.II 1959, Nr. 23, S. 585),
in Kraft für Deutschland seit 22. Juli 1959 (BGBl.II 1959, Nr. 39, S. 989)

- Verfahrensordnung des **Europäischen Kernenergie-Gerichts** vom 11. Dezember 1962 (BGBl.II 1965, Nr. 38, S. 1334)

1E-2.4 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, S. 434)
beide Übereinkommen in Kraft für Deutschland seit 15. Oktober 1989 (BGBl.II 1993, Nr. 34, S. 1830 und 1845)

1E-2.5 Internationales **Übereinkommen zur Bekämpfung nuklearterroristischer Handlungen** (International Convention for the Suppression of Acts of Nuclear Terrosrism) vom 13. April 2005, in Kraft seit 7. Juni 2007
Gesetz dazu vom 23. Oktober 2007 (BGBl.II 2007, Nr. 33, S. 1586)
in Kraft für Deutschland seit 9. März 2008 (BGBl.II 2008, Nr. 16, S. 671)

1E-2.6 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 dazu vom 29. Juli 1964 (BGBl.II 1964, Nr. 36, S. 857)
in Kraft für Deutschland seit 3. Juni 1965 (BGBl.II 1965, Nr. 46, S. 1579)
Neufassung vom 25. April 1968 (BGBl.II 1970, Nr. 20, S. 208)

1E-2.7 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 dazu vom 23. Juli 1973 (BGBl.II 1973, Nr. 37, S. 933)
in Kraft für Deutschland seit 26. September 1974 (BGBl.II 1973, Nr. 63, S. 1593)

1E-3 Radioactive waste management

1E-3.2 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 dazu vom 13. August 1998 (BGBl.II 1998, Nr. 31, S. 1752)
in Kraft für Deutschland seit 18. Juni 2001 (BGBl.II 2001, Nr. 36, S. 1283)

1E-4 Non-proliferation of nuclear weapons

1E-4.1 Vertrag über die Nichtverbreitung von Kernwaffen - **Atomwaffensperrvertrag** (Treaty on the Non-Proliferation of Nuclear Weapons - NPT, INFCIRC/140) vom 1. Juli 1968, in Kraft seit 5. März 1970
Gesetz dazu vom 4. Juni 1974 (BGBl.II 1974, Nr. 32, S. 785)
in Kraft für Deutschland seit 2. Mai 1975 (BGBl.II 1976, Nr. 25, S. 552)
Verlängerung des Vertrages auf unbegrenzte Zeit am 11. Mai 1995 (BGBl.II 1995, Nr. 34, S. 984)

1E-4.2 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, (A) and (4) of the Treaty on the Non-Proliferation of Nuclear Weapons, INFCIRC/193/Add. 8)) vom 5. April 1973, in Kraft für alle Vertragsparteien seit 21. Februar 1977, später ergänzt
Gesetz dazu vom 4. Juni 1974 (BGBl.II 1974, Nr. 32, S. 794)
Zusatzprotokoll vom 22. September 1998, in Kraft für Deutschland seit 30. April 2004
Gesetz zum Zusatzprotokoll vom 29. Januar 2000 (BGBl.I 2000, Nr. 4, S. 70)
Ausführungsgesetz zum Verifikationsabkommen und zum Zusatzprotokoll vom 29. Januar 2000 (BGBl.I 2000, Nr. 5, S. 74)

1E-5 Liability

1E-5.1 Übereinkommen über die Haftung gegenüber Dritten auf dem Gebiet der Kernenergie - Pariser Übereinkommen (Convention on Third Party Liability in the Field of Nuclear Energy - **Paris Convention**) vom 29. Juli 1960,
ergänzt durch das Protokoll vom 28. Januar 1964, in Kraft seit 1. April 1968,
ergänzt durch das Protokoll vom 16. November 1982, das Protokoll vom 12. Februar 1982, in Kraft seit 7. April 1988
und ergänzt durch das Protokoll vom 12. Februar 2004, noch nicht in Kraft
Gesetz dazu vom 8. Juli 1975 (BGBl.II 1975, Nr. 42, S. 957), zuletzt geändert durch Artikel 30 des Gesetzes vom 9. September 2001 (BGBl.I 2001, Nr. 47, S. 2331)
in Kraft für Deutschland seit 30. September 1975 (BGBl.II 1976, Nr. 12, S. 308),
Gesetz dazu vom 21. Mai 1985 (BGBl.II 1985, Nr. 19, S. 690)
in Kraft für Deutschland seit 7. Oktober 1988 (BGBl.II 1989, Nr. 6, S. 144)
Gesetz zum Protokoll 2004 vom 29. August 2008 (BGBl.II 2008, Nr. 24, S. 902)

1E-5.2 Zusatzübereinkommen zum Pariser Übereinkommen vom 29. Juli 1960 - Brüsseler Zusatzübereinkommen (Convention Supplementary to the Paris Convention of 29 July 1960 on Third Party Liability in the Field of Nuclear Energy - **Brussels Supplementary Convention**) vom 31. Januar 1963,
ergänzt durch das Protokoll vom 28. Januar 1964, in Kraft seit 4. Dezember 1974,
ergänzt durch das Protokoll vom 16. November 1982, in Kraft seit 1. Januar 1988
und ergänzt durch das Protokoll von 2004, noch nicht in Kraft
Gesetz dazu vom 8. Juli 1975 (BGBl.II 1975, Nr. 42 S. 957), zuletzt geändert durch Artikel 30 des Gesetzes vom 9. September 2001 (BGBl.I 2001, Nr. 47, S. 2331)
in Kraft für Deutschland seit 1. Januar 1976 (BGBl.II 1976, Nr. 12, S. 308)
Gesetz dazu vom 21. Mai 1985 (BGBl.II 1985, Nr. 19, S. 690)
in Kraft für Deutschland seit 7. Oktober 1988 (BGBl.I 1989, Nr. 6, S. 144)
Gesetz zum Protokoll 2004 vom 29. August 2008 (BGBl.II 2008, Nr. 24, S. 902)

1E-5.3 Internationales Nuklearhaftungsabkommen – Wiener Übereinkommen (Vienna Convention on Civil Liability for Nuclear Damage - **Vienna Convention,** INFCIRC/500) vom 21. Mai 1963, in Kraft seit 12. November 1977
ergänzt durch ein Protokoll vom 29. September 1997 (Protocol to Amend the 1963 Vienna Convention on Civil Liability for Nuclear Damage, INFCIRC/566)

1E-5.4 Gemeinsames Protokoll über die Anwendung des Wiener Übereinkommens und des Pariser Übereinkommens – Gemeinsames Protokoll (Joint Protocol Relating to the Application of the **Vienna Convention and the Paris Convention** - **Joint Protocol**, INFCIRC/402) vom 21. September 1988, in Kraft seit 27. April 1992
Gesetz dazu vom 5. Mai 2001 (BGBl.II 2001, Nr. 7, S. 202)
in Kraft für Deutschland seit 13. September 2001 (BGBl.II 2001, Nr. 24, S. 786)

1E-5.5 Übereinkommen über Nachzahlungen bei Nuklearschäden (Convention on **Supplementary**

Compensation for Nuclear Damage, INFCIRC/567) vom 29. September 1997, noch nicht in Kraft

1E-5.6 Übereinkommen über die zivilrechtliche **Haftung bei der Beförderung von Kernmaterial auf See** (Convention Relating to Civil Liability in the Field of Maritime Carriage of Nuclear Materials – NUCLEAR 1971) vom 17. Dezember 1971, in Kraft seit 15. Juli 1975
Gesetz dazu vom 8. Juli 1975 (BGBl.II 1975, Nr. 42, S. 957), zuletzt geändert durch Artikel 30 des Gesetzes vom 9. September 2001 (BGBl.I, Nr. 47, S. 2331)
in Kraft für Deutschland seit 30. Dezember 1975 (BGBl.II 1976, Nr. 12, S. 307)

1F Legal provisions of the European Union

1F-1 General provisions

1F-1.1 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. 1995, L 1)
Der Vertrag trat in seiner ursprünglichen Fassung am 1. Januar 1958 in Kraft (BGBl.II 1958, S. 1), die Neufassung trat am 1. November 1993 in Kraft (BGBl.II 1993, S. 1947), Berichtigung der Übersetzung des EURATOM-Vertrages vom 13. Oktober 1999 (BGBl.II 1999, Nr. 31)

1F-1.2 Beschluss 2008/114/EG, EURATOM des Rates vom 12. Februar 2008 über die Satzung der **EURATOM-Versorgungsagentur** (ABl. 2008, L 41)

1F-1.3 Empfehlung 91/444/EURATOM der Kommission vom 26. Juli 1991 zur **Anwendung von Artikel 33** des EURATOM-Vertrags (ABl. 1991, L 238)

1F-1.4 Empfehlung 2000/473/EURATOM der Kommission vom 8. Juni 2000 zur **Anwendung des Artikels 36** des EURATOM-Vertrags (ABl. 2000, L 191)

1F-1.5 Empfehlung 1999/829/EURATOM der Kommission vom 6. Dezember 1999 zur **Anwendung des Artikels 37** des EURATOM-Vertrags (ABl. 1999, L 324)

1F-1.6.1 Verordnung (EURATOM) 2587/1999 des Rates vom 2. Dezember 1999 zur Bestimmung der **Investitionsvorhaben**, die der Kommission **gemäß Artikel 41** des Vertrages zur Gründung der Europäischen Atomgemeinschaft **anzuzeigen** sind (ABl. 1999, L 315)

1F-1.6.2 Verordnung (EG) 1209/2000 der Kommission vom 8. Juni 2000 über die **Durchführungsbestimmungen** für die in Artikel 41 des Vertrages zur Gründung der Europäischen Atomgemeinschaft vorgeschriebenen Anzeigen (ABl. 2000, L 138), zuletzt geändert durch Verordnung (EURATOM) 1352/2003 der Kommission vom 23. Juli 2003 (ABl. 2003, L 192), letzte konsolidierte Fassung 2003

1F-1.7 Bekanntmachung über die Meldung an die Behörden der Mitgliedsstaaten auf dem Gebiet der **Sicherungsmaßnahmen gemäß Artikel 79** Abs. 2 des EURATOM-Vertrags vom 19. August 1999 (BGBl.II 1999, Nr. 25, S. 811)

1F-1.8 Verordnung (EURATOM) 302/2005 der Kommission vom 8. Februar 2005 über die Anwendung der **EURATOM-Sicherungsmaßnahmen** (ABl. 2005, L 54)

1F-1.9 **Verifikationsabkommen** siehe 1E-4 Nichtverbreitung von Atomwaffen [1E-4.2]

1F-1.11 Beschluss 1999/819/EURATOM der Kommission vom 16. November 1999 über den Beitritt der Europäischen Atomgemeinschaft - EAG - zum Übereinkommen über nukleare Sicherheit von 1994 (ABl. 1999, L 318), geändert durch Beschluss 2004/491/EURATOM der Kommission vom 29. April 2004 über den **Beitritt** der Europäischen Atomgemeinschaft **EAG zum Übereinkommen über nukleare Sicherheit** (ABl. 2004, L 172)

1F-1.12 Beschluss 2007/513/EURATOM des Rates vom 10. Juli 2007 zur Genehmigung des **Beitritt**es der Europäischen Atomgemeinschaft - EAG - zu dem **geänderten Übereinkommen über den Physischen Schutz von Kernmaterial und Kernanlagen** (Convention on the Physical Protection of Nuclear Material and Nuclear Facilities - CPPNM, vgl. 1E-2.2) und **Erklärung** der Europäischen Atomgemeinschaft gemäß Artikel 18 Absatz 4 und Artikel 17 Absatz 3 des CPPNM (ABl. 2007, L 190)

1F-1.13 Verordnung (EURATOM) 300/2007 des Rates vom 19. Februar 2007 zur Schaffung eines **Instrumentes für Zusammenarbeit im Bereich der nuklearen Sicherheit** (ABl. 2007, L 81)

1F-1.14 Beschluss 2007/530/EURATOM des Rates vom 17. Juli 2007 zur **Einsetzung der Europäischen**

hochrangigen Gruppe für nukleare Sicherheit und Abfallentsorgung (ABl. 2007, L 195)

1F-1.15 Richtlinie 85/337/EWG des Rates vom 27. Juni 1985 über die **Umweltverträglichkeitsprüfung** bei bestimmten öffentlichen und privaten Projekten (ABl. 1985, L 175), zuletzt geändert durch die Richtlinie 2009/31/EWG des EP und des Rates vom 23. April 2009 (ABl. 2009, L 140), letzte konsolidierte Fassung 2009
Hinweis: Umsetzung s. UVP-Gesetz [1B-3]

1F-1.16 Richtlinie 2001/42/EG des EP und des Rates vom 27. Juni 2001 über die **Prüfung der Umweltauswirkungen** bestimmter Pläne und Programme (ABl. 2001, L 197)
Hinweis: Umsetzung s. UVP-Gesetz [1B-3]

1F-1.17 Richtlinie 2003/4/EG des EP und des Rates vom 28. Januar 2003 über den **Zugang der Öffentlichkeit zu Umweltinformationen** und zur Aufhebung der RL 90/313/EWG des Rates (ABl. 2003, L 41)
Hinweis: Umsetzung s. UI-Gesetz [1B-2.1]

1F-1.18 Verordnung (EG) 1221/2009 des EP und des Rates vom 25. November 2009 über die freiwillige Beteiligung von Organisationen an einem **Gemeinschaftssytem für das Umweltmanagement und die Umweltbetriebsprüfung** – EMAS (ABl. 2009, L 342)

1F-1.19 Richtlinie 2008/99/EG des EP und des Rates vom 19. November 2008 über den **strafrechtlichen Schutz der Umwelt** (ABl. 2008, L 328)

1F-1.20 Richtlinie 98/34/EG des EP und des Rates vom 22. Juni 1998 über ein **Informationsverfahren** auf dem Gebiet der Normen und **technischen Vorschriften** (ABl. 1998, L 204), mehrfach geändert, letzte konsolidierte Fassung 2007

1F-1.21 Richtlinie 2006/42/EG des EP und des Rates vom 17. Mai 2006 über **Maschinen** und zur Änderung der Richtlinie 95/16/EG (ABl. 2006, L 157), berichtigt und geändert, letzte konsolidierte Fassung 2009

1F-1.24 Empfehlung 2009/120/EURATOM der Kommission vom 11. Januar 2009 über die Umsetzung eines **Kernmaterialbuchführungs- und -kontrollsystems** durch Betreiber kerntechnischer Anlagen (ABl. 2009, L 41)

1F-1.25 Richtlinie 2009/71/EURATOM des Rates vom 25. Juni 2009 über einen **Gemeinschaftsrahmen für nukleare Sicherheit kerntechnischer Anlagen** (ABl. 2009, L 172)

1F-2 Radiation protection

1F-2.1 Richtlinie 96/29/EURATOM des Rates vom 13. Mai 1996 zur Festlegung der grundlegenden Sicherheitsnormen für den Schutz der Gesundheit der Arbeitskräfte und der Bevölkerung gegen die Gefahren durch ionisierende Strahlen (**EURATOM-Grundnormen**) (ABl. 1996, L 159), berichtigt am 4. Dezember 1996 (ABl. 1998, L 314)

1F-2.2 Richtlinie 2003/122/EURATOM des Rates vom 22. Dezember 2003 zur **Kontrolle hochradioaktiver Strahlenquellen** und **herrenloser Strahlenquellen** (ABl. 2003, L 346)

1F-2.3 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. 1990, L 349)

1F-2.4 Richtlinie 94/33/EG des Rates vom 22. Juni 1994 über **Jugendarbeitsschutz** (ABl. 1994, L 216), geändert durch Richtlinie 2007/30/EG vom 20. Juni 2007 (ABl. 2007, L 165)

1F-2.5 Empfehlung 2004/2/EURATOM der Kommission vom 18. Dezember 2003 zu standardisierten Informationen über **Ableitungen radioaktiver Stoffe** mit der **Fortluft** und dem A**bwasser aus Kernkraftwerken und Wiederaufarbeitungsanlagen** in die Umwelt im Normalbetrieb (ABl. 2004, L 2), Berichtigung (ABl. 2004, L 63)

1F-3 Radioactive waste, transport of radioactive material

1F-3.2 Verordnung (EG) 428/2009 des Rates vom 5. Mai 2009 über eine Gemeinschaftsregelung für die **Kontrolle der Ausfuhr, der Verbringung, der Vermittlung und der Durchfuhr von Gütern mit doppeltem Verwendungszweck** (ABl. 2009, L 134), berichtigt, letzte konsolidierte Fassung von 2009

1F-3.3 Verordnung (EURATOM) 1493/93 des Rates vom 8. Juni 1993 über die **Verbringung radioaktiver Stoffe zwischen den Mitgliedsstaaten** (ABl. 1993, L 148)

- Mitteilung der Kommission vom 10. Dezember 1993 zu der Verordnung EURATOM/1493/93 (ABl. 1993, C 335)

1F-3.4 Verordnung EURATOM 66/2006 der Kommission vom 16. Januar 2006 betreffend die **Ausnahme kleiner Mengen von Erzen, Ausgangsstoffen und besonderen spaltbaren Stoffen** von den Vorschriften des Kapitels über die Versorgung (ABl. 2006, L 11)

1F-3.6 Beschluss 2005/84/EURATOM des Rates vom 24. Januar 2005 zur Genehmigung des Beitritts der Europäischen Atomgemeinschaft zum **Gemeinsamen Übereinkommen über die Sicherheit der Behandlung abgebrannter Brennelemente und über die Sicherheit der Behandlung radioaktiver Abfälle** (ABl. 2005, L 30), Entscheidung 2005/510/EURATOM der Kommission vom 14. Juni 2005 dazu (ABl. 2005, L 185)

1F-3.7 Empfehlung 2006/851/EURATOM der Kommission vom 24. Oktober 2006 für die Verwaltung der **Finanzmittel für die Stilllegung kerntechnischer Anlagen und die Entsorgung abgebrannter Brennelemente und radioaktiver Abfälle** (ABl. 2006, L 330)

1F-3.8 Empfehlung 99/669/EG der Kommission für ein **Klassifizierungssystem für feste radioaktive Abfälle** (ABl. 1998, L 265)

1F-3.9 Richtlinie 2006/117/EURATOM des Rates vom 20. November 2006 über die Überwachung und Kontrolle der **Verbringung radioaktiver Abfälle und abgebrannnter Brennelemente** (ABl. 2006, L 337)

- Entscheidung 2008/312/EURATOM der Kommission vom 5. März 2008 zur Empfehlung des in der Richtlinie 2006/117/EURATOM des Rates genannten **einheitlichen Begleitscheins** für die Überwachung und Kontrolle der Verbringung radioaktiver Abfälle und abgebrannter Brennelemente (ABl. 2008, L 107)
- Empfehlung 2008/956/EURATOM der Kommission vom 4. Dezember 2008 über die **Kriterien für die Ausfuhr** radioaktiver Abfälle und abgebrannter Brennelemente in Drittländer (ABl. 2008, L 33)
- Empfehlung 2009/527/EURATOM der Kommission vom 7. Juli 2009 für ein sicheres und effizientes System zur **Übermittlung von Unterlagen und Informationen** im Zusammenhang mit der Richtlinie 2006/117/EURATOM (ABl. 2009, L 177)

1F-4 Radiological emergency preparedness

1F-4.1 Entscheidung 87/600/EURATOM des Rates vom 14. Dezember 1987 über Gemeinschaftsvereinbarungen für den **beschleunigten Informationsaustausch** im Fall einer radiologischen Notstandssituation (ECURIE) (ABl. 1987, L 371)

1F-4.2 Abkommen zwischen **EURATOM und Nichtmitgliedsstaaten der EU** über die Teilnahme an Vereinbarungen in der Gemeinschaft für den schnellen Austausch von Informationen in einer radiologischen Notstandssituation (ECURIE) (ABl. 2003, C 102)

1F-4.3 Beschluss der Kommission 2005/844/EURATOM vom 25. November 2005 über den **Beitritt** der Europäischen Atomgemeinschaft zum **Übereinkommen über die frühzeitige Benachrichtigung** bei nuklearen Unfällen (ABl. 2005, L 314)

1F-4.4 Beschluss der Kommission 2005/845/EURATOM vom 25. November 2005 über den **Beitritt** der Europäischen Atomgemeinschaft zum **Übereinkommen über Hilfeleistung bei nuklearen Unfällen oder radiologischen Notfällen** (ABl. 2005, L 314)

1F-4.5 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. 1989, L 357)

1F-4.6 Entscheidung 2007/779/EG, EURATOM des Rates vom 8. November 2007 über ein **Gemeinschaftsverfahren für den Katastrophenschutz** (ABl. 2007, L 314)

1F-4.7 Entscheidung 2007/162/EG, EURATOM des Rates vom 5. März 2007 zur Schaffung eines **Finanzierungsinstruments für den Katastrophenschutz** (ABl. 2007, L 71), gültig bis 31. Dezember 2013

1F-4.8 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. 1987, L 371) geändert durch Ratsverordnung (EURATOM) 2218/89 vom 18. Juli 1989 (ABl. 1989, L 211)
- Kommissionsverordnung (EURATOM) 944/89 vom 12. April 1989 (ABl. 1989, L 101)
- Kommissionsverordnung (EURATOM) 770/90 vom 29. März 1990 (ABl. 1990, L 83)

1F4.9 Ratsverordnung (EWG) 2219/89 vom 18. Juli 1989 über **besondere Bedingungen für die Ausfuhr** von Nahrungsmitteln und Futtermitteln im Falle eines **nuklearen Unfall**s oder einer anderen radiologischen Notstandssituation (ABl. 1989, L 211)

1F-4.10.1 Verordnung (EG) 733/2008 des Rates vom 15. Juli 2008 über die **Einfuhrbedingungen für landwirtschaftliche Erzeugnisse** mit Ursprung in Drittländern **nach** dem Unfall im Kernkraftwerk **Tschernobyl** (ABl. 2008, L 201), geändert, letzte konsolidierte Fassung 2009

1F-4.10.2 Verordnung (EG) 1635/2006 der Kommission vom 6. November 2006 zur Festlegung der **Durchführungsbestimmungen der VO (EWG) 737/90** (ABl. 2006, L 306)

1F-4.10.3 Verordnungen (EG) 1609/2000 der Kommission vom 24. Juli 2000 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 (ABl. 2000, L 185)

2 General administrative provisions

2-1 Allgemeine Verwaltungsvorschrift zu § 45 Strahlenschutzverordnung: **Ermittlung der Strahlenexposition durch die Ableitung** radioaktiver Stoffe aus kerntechnischen Anlagen oder Einrichtungen vom 21. Februar 1990 (BAnz. 1990, Nr. 64a), in Überarbeitung

2-2 Allgemeine Verwaltungsvorschrift zu § 40 Abs. 2, § 95 Abs. 3 Strahlenschutzverordnung und § 35 Abs. 2 Röntgenverordnung (**AVV Strahlenpass**) vom 20. Juli 2004 (BAnz. 2004, Nr. 142a)

2-3 Allgemeine Verwaltungsvorschrift zur Ausführung des Gesetzes über die **Umweltverträglichkeitsprüfung** (UVPVwV) vom 18. September 1995 (GMBl. 1995, Nr. 32, S. 671)

2-4 Allgemeine Verwaltungsvorschrift zum **Integrierten Meß- und Informationssystem** zur Überwachung der Radioaktivität in der Umwelt nach dem Strahlenschutzvorsorgegesetz (AVV-IMIS) vom 13. Dezember 2006 (BAnz. 2006, Nr. 244a)

2-5 Allgemeine Verwaltungsvorschrift zur Durchführung der **Überwachung von Lebensmitteln** nach der Verordnung (Euratom) Nr. 3954/87 des Rates vom 22. Dezember 1987 zur Festlegung von Höchstwerten an Radioaktivität in Nahrungsmitteln und Futtermitteln im Falle eines nuklearen Unfalls oder einer anderen radiologischen Notstandssituation (AVV-Strahlenschutzvorsorge-Lebensmittelüberwachung - AVV-StrahLe) vom 28. Juni 2000 (GMBl. 2000, Nr. 25, S. 490)

2-6 Allgemeine Verwaltungsvorschrift zur Überwachung der **Höchstwerte für Futtermittel** nach der Verordnung (Euratom) Nr. 3954/87 des Rates vom 22. Dezember 1987 zur Festlegung von Höchstwerten an Radioaktivität in Nahrungsmitteln und Futtermitteln im Falle eines nuklearen Unfalls oder einer anderen radiologischen Notstandssituation (Futtermittel-Strahlenschutzvorsorge-Verwaltungsvorschrift - FMStrVVwV) vom 22. Juni 2000 (BAnz. 2000, Nr. 122)

2-7 Allgemeine Verwaltungsvorschrift für die Durchführung des Schnellwarnsystems für Lebensmittel, Lebensmittelbedarfsgegenstände und Futtermittel (AVV **Schnellwarnsystem** – AVV SWS) vom 20. Dezember 2005 (BAnz. 2005, Nr. 245, S. 17096), in der Fassung vom 28. Januar 2010 (BAnz. 2010, Nr. 18, S. 406)

3 Regulatory guidelines published by BMU and the formerly competent Ministry of the Interior

3-0 **Sicherheitskriterien für Kernkraftwerke** (Revision D) vom April 2009 in der Erprobungsphase vom 1. Juli 2009 bis 31. Oktober 2010

3-1 **Sicherheitskriterien für Kernkraftwerke** vom 21. Oktober 1977 (BAnz. 1977, Nr. 206)
Hinweis. Soll ersetzt werden durch Sicherheitskriterien für Kernkraftwerke (Revision D) vom April 2009 [3-0]

3-2 Richtlinie für den **Fachkundenachweis von Kernkraftwerkspersonal** vom 14. April 1993 (GMBl. 1993, Nr. 20, S. 358)
Hinweis: Nach einer probeweisen Anwendung für 3 Jahre (ab 1. Januar 2005) wurde vom Fachausschuss für Reaktorsicherheit einer Ergänzung für das verantwortliche Kernkraftwerkspersonal am 17. November 2008 zugestimmt (Aktenzeichen RS I6-13 831-2/1)

3-3 Richtlinie für den **Fachkundenachweis von Forschungsreaktorpersonal** vom 16. Februar 1994 (GMBl. 1994, Nr. 11, S. 366)

3-4 Richtlinien über die **Anforderungen an Sicherheitsspezifikationen** für Kernkraftwerke vom 27. April 1976 (GMBl. 1976, Nr. 15, S. 199)

3-5 **Merkpostenaufstellung** mit Gliederung **für einen Standardsicherheitsbericht für Kernkraftwerke** mit Druckwasserreaktor oder Siedewasserreaktor vom 26. Juli 1976 (GMBl. 1976, Nr. 26, S. 418)

3-6 Richtlinie für den Schutz von Kernkraftwerken gegen **Druckwellen** aus chemischen Reaktionen durch Auslegung der Kernkraftwerke hinsichtlich ihrer Festigkeit und induzierten Schwingungen sowie durch Sicherheitsabstände vom 13. September 1976 (BAnz. 1976, Nr. 179)

3-7.1 **Zusammenstellung** der in atomrechtlichen Genehmigungs- und Aufsichtsverfahren für Kernkraftwerke zur Prüfung erforderlichen **Informationen (ZPI)** vom 20. Oktober 1982 (BAnz. 1983, Nr. 6a)

3-7.2 Zusammenstellung der zur **bauaufsichtlichen Prüfung** kerntechnischer Anlagen erforderlichen **Unterlagen** vom 6. November 1981 (GMBl. 1981, Nr. 33, S. 518)

3-8 Grundsätze für die **Vergabe von Unteraufträgen durch Sachverständige** vom 29. Oktober 1981 (GMBl. 1981, Nr. 33, S. 517)

3-9.1 **Grundsätze zur Dokumentation** technischer Unterlagen durch Antragsteller /Genehmigungsinhaber bei Errichtung, Betrieb und Stilllegung von Kernkraftwerken vom 19. Februar 1988 (BAnz. 1988, Nr. 56)

3-9.2 **Anforderungen an die Dokumentation** bei Kernkraftwerken vom 5. August 1982 (GMBl. 1982, Nr. 26, S. 546)

3-10 Durchführung der Strahlenschutzverordnung und der Röntgenverordnung; **Berichterstattung über besondere Vorkommnisse** vom 15. Juli 2002 (GMBl. 2002, Nr. 31, S. 637)

3-11 **Sicherheitsanforderungen an Kernbrennstoffversorgungsanlagen** von April 1997 und Juni 2004, BMU RS III 3

3-12 Bewertungsdaten für **Kernkraftwerksstandorte** vom 11. Juni 1975 (Umwelt 1975, Nr. 43)

3-13 **Sicherheitskriterien für die Endlagerung** radioaktiver Abfälle in einem Bergwerk vom 20. April 1983 (GMBl. 1983, Nr. 13, S. 220), in Überarbeitung

3-14 Auslegungsrichtlinien und -richtwerte für **Jod-Sorptionsfilter** zur Abscheidung von gasförmigem Spaltjod in Kernkraftwerken vom 25. Februar 1976 (GMBl. 1976, Nr. 13, S. 168)

3-15.1 **Rahmenempfehlungen für den Katastrophenschutz** in der Umgebung kerntechnischer Anlagen vom 27. Oktober 2008 (GMBl. 2008, Nr. 62/63, S. 1278)

3-15.2 **Radiologische Grundlagen** für Entscheidungen über Maßnahmen zum **Schutz der Bevölkerung bei unfallbedingten Freisetzungen von Radionukliden** vom 27. Oktober 2008 (GMBl. 2008, Nr. 62/63, S. 1278) mit der Anlage „Verwendung von Jodtabletten zur **Jodblockade** der Schilddrüse bei einem kerntechnischen Unfall“

3-19 Richtlinie nach StrlSchV und RöV „**Arbeitsmedizinische Vorsorge beruflich strahlenexponierter Personen** durch ermächtigte Ärzte“ vom 18. Dezember 2003 (GMBl. 2004, Nr. 19, S. 350)

3-23 Richtlinie zur **Emissions- und Immissionsüberwachung kerntechnischer Anlagen (REI)** vom 7. Dezember 2005 (GMBl. 2006, Nr. 14-17, S. 254)

3-24 Richtlinie über **Dichtheitsprüfungen an umschlossenen radioaktiven Stoffen** vom 20. Januar und 4. Februar 2004 (GMBl. 2004, Nr. 27, S. 530)

3-25 Grundsätze zur **Entsorgungsvorsorge** für Kernkraftwerke vom 19. März 1980 (BAnz. 1980, Nr. 58)

3-27 Richtlinie über die Gewährleistung der notwendigen **Kenntnisse** der beim Betrieb von Kernkraftwerken **sonst tätigen Personen** vom 30. November 2000 (GMBl. 2001, Nr. 8, S. 153)

3-31 Empfehlungen zur **Planung von Notfallschutzmaßnahmen** durch Betreiber von Kernkraftwerken vom 27. Dezember 1976 (GMBl. 1977, Nr. 4, S. 48), geändert durch Bekanntmachung vom 18. Oktober 1977 (GMBl. 1977, Nr. 30, S 664) und die REI (GMBl. 1993, Nr. 29, S. 502)

3-33.1 Leitlinien zur Beurteilung der Auslegung von Kernkraftwerken mit Druckwasserreaktoren gegen Störfälle im Sinne des § 28 Abs. 3 StrlSchV (**Störfall-Leitlinien**) vom 18. Oktober 1983 (BAnz. 1983, Nr. 245a)
Hinweis: Soll ersetzt werden durch Sicherheitskriterien für Kernkraftwerke (Revision D) vom April 2009 [3-0]

3-33.2 **Störfallberechnungsgrundlagen** für die Leitlinien zur Beurteilung der Auslegung von Kernkraftwerken mit DWR gemäß § 28 Abs. 3 StrlSchV vom 18. Oktober 1983 (BAnz. 1983, Nr. 245a), Fassung des Kapitels 4 "Berechnung der Strahlenexposition" vom 29. Juni 1994 (BAnz. 1994, Nr. 222a), Neufassung des Kapitels 4 "Berechnung der Strahlenexposition" gemäß § 49 StrlSchV vom 20. Juli 2001 verabschiedet auf der 186. Sitzung der Strahlenschutzkommission am 11. September 2003, veröffentlicht in der Reihe "Berichte der Strahlenschutzkommission", Heft 44, 2004

3-34 Rahmenrichtlinie über die Gestaltung von **Sachverständigengutachten** in atomrechtlichen Verwaltungsverfahren vom 15. Dezember 1983 (GMBl. 1984, Nr. 2, S. 21)

3-37 Empfehlung über den Regelungsinhalt von Bescheiden bezüglich der **Ableitung radioaktiver Stoffe** aus Kernkraftwerken mit Leichtwasserreaktor vom 8. August 1984 (GMBl. 1984, Nr. 21, S. 327)

3-38 Richtlinie für Programme zur **Erhaltung der Fachkunde** des verantwortlichen **Schichtpersonals** in Kernkraftwerken vom 1. September 1993 (GMBl. 1993, Nr. 36, S. 645)

3-39 Richtlinie für den Inhalt der **Fachkundeprüfung** des verantwortlichen **Schichtpersonals** in Kernkraftwerken vom 23. April 1996 (GMBl. 1996, Nr. 26, S. 555)

3-40 Richtlinie über die im Strahlenschutz erforderliche Fachkunde (**Fachkunde-Richtlinie Technik nach Strahlenschutzverordnung**) vom 21. Juni 2004 (GMBl. 2004, Nr. 40/41, S. 799), Änderung vom 19. April 2006 (GMBl. 2006, Nr. 38, S. 735)

3-41 Richtlinie für das Verfahren zur Vorbereitung und Durchführung von **Instandhaltungs- und Änderungsarbeiten** in Kernkraftwerken vom 1. Juni 1978 (GMBl. 1978, Nr. 22, S. 342), in Überarbeitung

3-42.1 Richtlinie für die Physikalische Strahlenschutzkontrolle zur Ermittlung der Körperdosen
Teil 1: Ermittlung der **Körperdosis bei äußerer Strahlenexposition** (§§ 40, 41, 42 StrlSchV; § 35 RöV) vom 8. Dezember 2003 (GMBl. 2004, Nr. 22, S. 410)

3-42.2 Richtlinie für die physikalische Strahlenschutzkontrolle zur Ermittlung der Körperdosen
Teil 2: Ermittlung der **Körperdosis bei innerer Strahlenexposition** (Inkorporationsüberwachung) (§§ 40, 41 und 42 StrlSchV)“ vom 12. Januar 2007 (GMBl. 2007, Nr. 31/32, S. 623)

3-43.1 Richtlinie für den **Strahlenschutz des Personals** bei der Durchführung von **Instandhaltungsarbeiten** in Kernkraftwerken mit Leichtwasserreaktor:
Teil I: Die während der Planung der Anlage zu treffende Vorsorge – **IWRS I** - vom 10. Juli 1978 (GMBl. 1978, Nr. 28, S. 418), in Überarbeitung

3-43.2 Richtlinie für den **Strahlenschutz des Personals** bei **Tätigkeiten der Instandhaltung, Änderung, Entsorgung und des Abbaus** in kerntechnischen Anlagen und Einrichtungen:
Teil 2: Die Strahlenschutzmaßnahmen während des Betriebs und der Stilllegung einer Anlage oder Einrichtung - **IWRS II** - vom 17. Januar 2005 (GMBl. 2005, Nr. 13, S. 258)

3-44 **Kontrolle der Eigenüberwachung** radioaktiver Emissionen aus Kernkraftwerken vom 5. Februar 1996 (GMBl. 1996, Nr. 9/10, S. 247)

3-49 Interpretationen zu den Sicherheitskriterien für Kernkraftwerke; **Einzelfehlerkonzept** - Grundsätze für die Anwendung des Einzelfehlerkriteriums vom 2. März 1984 (GMBl. 1984, Nr. 13, S. 208)

3-50 **Interpretationen zu den Sicherheitskriterien** für Kernkraftwerke vom 17. Mai 1979 (GMBl. 1979, Nr. 14, S. 161)
zu Sicherheitskriterium 2.6: Einwirkungen von außen
zu Sicherheitskriterium 8.5: Wärmeabfuhr aus dem Sicherheitseinschluss

3-51 **Interpretationen zu den Sicherheitskriterien** für Kernkraftwerke vom 28. November 1979 (GMBl. 1980, Nr. 5, S. 90)
zu Sicherheitskriterium 2.2: Prüfbarkeit
zu Sicherheitskriterium 2.3: Strahlenbelastung in der Umgebung
zu Sicherheitskriterium 2.6: Einwirkungen von außen
zu Sicherheitskriterium 2.7: Brand- und Explosionsschutz
ergänzende Interpretation zu Sicherheitskriterium 4.3: Nachwärmeabfuhr nach Kühlmittelverlusten

3-52.2 **Erläuterungen zu den Meldekriterien** für meldepflichtige Ereignisse in Anlagen zur Spaltung von Kernbrennstoffen (12/04)
- Zusammenstellung von in den Meldekriterien verwendeten Begriffen (Anlagen zur Spaltung von Kernbrennstoffen) (05/04)
- Meldeformular (Anlagen zur Spaltung von Kernbrennstoffen) (04/04)

3-52.3 **Erläuterungen zu den Meldekriterien** für meldepflichtige Ereignisse **in Anlagen, die nicht der Spaltung von Kernbrennstoffen dienen** (Stand 01/97)
- Meldeformular (Anlagen die nicht der Spaltung von Kernbrennstoffen dienen) (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 Spaltprodukten (08/00)
- Meldeformular (Behälter) (07/00)

3-52.5 **Erläuterungen zu den Meldekriterien** für meldepflichtige Ereignisse in Anlagen zur Spaltung von Kernbrennstoffen - für die Anwendung **in Forschungsreaktoren** (11/92)

3-53 Richtlinie für den Inhalt der **Fachkundeprüfung** des verantwortlichen **Schichtpersonals in Forschungsreaktoren** vom 14. November 1997 (GMBl. 1997, Nr. 42, S. 794)

3-54.1 Rahmenempfehlung für die **Fernüberwachung** von Kernkraftwerken vom 12. August 2005 (GMBl. 2005, Nr. 51, S. 1049)

3-54.2 Empfehlung zur Berechnung der **Gebühr nach § 5 AtKostV für die Fernüberwachung** von Kernkraftwerken (KFÜ) vom 21. Januar 1983 (GMBl. 1983, Nr. 8, S. 146)

3-57.1 Anforderungen an den **Objektsicherungsdienst** und an Objektsicherungsbeauftragte in kerntechnischen Anlagen und Einrichtungen (OSD-Richtlinie) vom 4. Juli 2008 (GMBl. 2008, Nr. 39, S. 810)

3-57.3 Richtlinie für den **Schutz von Kernkraftwerken** mit Leichtwasserreaktoren gegen Störmaßnahmen oder sonstige **Einwirkungen Dritter** vom 06.12.1995 (GMBl. 1996, S. 32, Nr. 2, ohne Wortlaut)

3-60 Richtlinie zur **Kontrolle radioaktiver Reststoffe und radioaktiver Abfälle** vom 19. November 2008 (BAnz. 2008, Nr. 197)

3-61 Richtlinie für die **Fachkunde von Strahlenschutzbeauftragten** in Kernkraftwerken und sonstigen Anlagen zur Spaltung von Kernbrennstoffen vom 10. Dezember 1990 (GMBl. 1991, Nr. 4, S. 56)

3-62 Richtlinie über Maßnahmen für den **Schutz von Anlagen des Kernbrennstoffkreislaufs** und sonstigen kerntechnischen Einrichtungen gegen Störmaßnahmen oder sonstige **Einwirkungen zugangsberechtigter Einzelpersonen** vom 28. Januar 1991 (GMBl. 1991, Nr. 9, S. 228)

3-65 Anforderungen an Lehrgänge zur Vermittlung kerntechnischer Grundlagenkenntnisse für verantwortliches Schichtpersonal in Kernkraftwerken - **Anerkennungskriterien** - vom 10. Oktober 1994

3-67 Richtlinie über Anforderungen an **Personendosismessstellen** nach Strahlenschutz- und Röntgenverordnung vom 10. Dezember 2001 (GMBl. 2002, Nr. 6, S. 136)

3-68 Sicherungsmaßnahmen für den Schutz von kerntechnischen Anlagen mit Kernmaterial der Kategorie III vom 20. April 1993 (GMBl. 1993, Nr. 20, S. 365, ohne Wortlaut)

3-69.1 Richtlinie für die **Überwachung der Radioaktivität in der Umwelt** nach dem

Strahlenschutzvorsorgegesetz
Teil I: Meßprogramm für den Normalbetrieb (**Routinemessprogramm**) vom 28. Juli 1994 (GMBl. 1994, Nr. 32, S. 930), in Überarbeitung

3-69.2 Richtlinie für die **Überwachung der Radioaktivität in der Umwelt** nach dem Strahlenschutzvorsorgegesetz
Teil II: Meßprogramm für den Intensivbetrieb (**Intensivmessprogramm**) vom 19. Januar 1995 (GMBl. 1995, Nr. 14, S. 261), in Überarbeitung

3-71 Richtlinie für die **Fachkunde** von verantwortlichen Personen in **Anlagen zur Herstellung von Brennelementen** für Kernkraftwerke vom 30. November 1995 (GMBl. 1996, Nr. 2, S. 29)

3-73 Leitfaden zur **Stilllegung, zum sicheren Einschluss und zum Abbau von Anlagen oder Anlagenteilen** nach § 7 des Atomgesetzes vom 26. Juni 2009 (BAnz. 2009, Nr. 162a)

3-74.1 Leitfaden zur Durchführung von **Periodischen Sicherheitsüberprüfungen** (PSÜ) für Kernkraftwerke in der Bundesrepublik Deutschland, in Überarbeitung
- **Grundlagen** zur Periodischen Sicherheitsprüfung für Kernkraftwerke
- Leitfaden **Sicherheitsstatusanalyse**
- Leitfaden **Probabilistische Sicherheitsanalyse**

Bekanntmachung vom 18. August 1997 (BAnz. 1997, Nr. 232a)

3-74.2 Leitfaden zur Durchführung von **Periodischen Sicherheitsüberprüfungen** (PSÜ) für Kernkraftwerke in der Bundesrepublik Deutschland, in Überarbeitung
- Leitfaden **Deterministische Sicherungsanalyse**

Bekanntmachung vom 25. Juni 1998 (BAnz. 1998, Nr. 153)

3-74.3 Leitfaden zur Durchführung der Sicherheitsüberprüfung gemäß § 19a des Atomgesetzes
- Leitfaden **Probabilistische Sicherheitsanalyse**

Bekanntmachung vom 30. August 2005 (BAnz. 2005, Nr. 207)

3-75 Merkpostenliste für die **Sicherung sonstiger radioaktiver Stoffe** und kleiner Mengen Kernbrennstoff gegen Entwendung aus Anlagen und Einrichtungen vom 3. April 2003, RdSchr. des BMU vom 10. Juli 2003 - RS I 6 13151-6/.18

3-79 **Schadensvorsorge** außerhalb der Auslegungsstörfälle, RdSchr. des BMU vom 15. Juli 2003, RS I 3 - 10100/0

3-80 Entschließung des Länderausschusses für Atomkernenergie zu **Entscheidungen nach der Strahlenschutzverordnung**, deren Wirkung über den Bereich eines Landes hinausgeht, RdSchr. des BMU vom 8. Dezember 2003 RS I 1 - 17031/47

3-81 Grundlagen für **Sicherheitsmanagementsysteme** in Kernkraftwerken,
Bekanntmachung des BMU vom 29. Juni 2004 (BAnz. 2004, Nr. 138)

4 Other relevant provisions and recommendations

4-1 **RSK-Leitlinien für Druckwasserreaktoren**
3. Ausgabe vom 14. Oktober 1981 (BAnz. 1982, Nr. 69a) mit den Änderungen:
in Abschnitt 21.1 (BAnz. 1984, Nr. 104)
in Abschnitt 21.2 (BAnz. 1983, Nr. 106) und
in Abschnitt 7 (BAnz. 1996, Nr. 158a) mit Berichtigung (BAnz. 1996, Nr. 214)
und den Anhängen vom 25. April 1979 zu Kapitel 4.2 der 2. Ausgabe der RSK-LL vom 24. Januar 1979 (BAnz. 1979, Nr. 167a)
Anhang 1: Auflistung der Systeme und Komponenten, auf die die Rahmenspezifikation Basissicherheit von druckführenden Komponenten anzuwenden ist
Anhang 2: Rahmenspezifikation Basissicherheit; Basissicherheit von druckführenden Komponenten: Behälter, Apparate, Rohrleitungen, Pumpen und Armaturen (ausgenommen: Einbauteile, Bauteile zur Kraftübertragung und druckführende Wandungen < DN 50)
Hinweis: Soll ersetzt werden durch Sicherheitskriterien für Kernkraftwerke (Revision D) vom April 2009 [3-0]

4-2 **Kriterien für die Alarmierung der Katastrophenschutzbehörde** durch die Betreiber kerntechnischer Einrichtungen (Alarmierungskriterien)
Gemeinsame Stellungnahme der Strahlenschutzkommission und der Reaktor-Sicherheitskommission, 1994, revidiert 2003, (BAnz 2004, Nr. 89)
verabschiedet auf der 186. Sitzung der SSK am 11./12.09.2003
verabschiedet auf der 366. Sitzung der RSK am 16.10.2003
veröffentlicht in der Reihe „Berichte der Strahlenschutzkommission", Heft 39

4-2.1 **Erläuterungen zu den Kriterien für die Alarmierung der Katastrophenschutzbehörde** durch die Betreiber kerntechnischer Anlagen
Gemeinsame Stellungnahme der Strahlenschutzkommission und der Reaktor-Sicherheitskommission (BAnz. 1994, Nr. 96)
verabschiedet auf der 127. Sitzung der SSK am 12.10.1994
verabschiedet auf der 288. Sitzung der RSK am 14.12.1994
veröffentlicht in der Reihe „Berichte der Strahlenschutzkommission", Heft 36

4-3 Übersicht über **Maßnahmen zur Verringerung der Strahlenexposition nach Ereignissen mit nicht unerheblichen radiologischen Auswirkungen** (Maßnahmenkatalog), Band 1 und 2
herausgegeben vom Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Oktober 1999
Teil 3: Behandlung und Entsorgung kontaminierter landwirtschaftlicher Produkte
verabschiedet auf der 200. Sitzung der SSK am 30.06./01.07.2005

4-4 **Leitfaden für den Fachberater Strahlenschutz der Katastrophenschutzleitung** bei kerntechnischen Notfällen
Stellungnahme der Strahlenschutzkommission
verabschiedet auf der 182. Sitzung der SSK am 04.-06.12.2002
veröffentlicht in der Reihe „Berichte der Strahlenschutzkommission", Heft 37

4-4.1 **Erläuterungsbericht zum Leitfaden für den Fachberater Strahlenschutz der Katastrophenschutzleitung**
Stellungnahme der Strahlenschutzkommission
verabschiedet auf der 185. Sitzung der SSK am 03./04.07.2003
veröffentlicht in der Reihe „Berichte der Strahlenschutzkommission", Heft 38

4-5 **Feuerwehrdienstvorschrift FwDV 500 „Einheiten im ABC-Einsatz"**, Stand 2003
Die FwDV 500 wurde am 15. und 16.09.2003 vom Ausschuss Feuerwehrangelegenheiten, Katastrophenschutz und zivile Verteidigung (AFKzV) genehmigt und den Ländern zur Einführung empfohlen.
Erläuterungen der Projektgruppe Feuerwehr-Dienstvorschriften des Instituts der Feuerwehr zur FwDV 500 „Einheiten im ABC-Einsatz" ,Stand: 02/2004

4-6 **Leitfaden Polizei LF 450 "Gefahren durch chemische, radioaktive und biologische Stoffe"**
Ausgabe 2005, Stand: 10.11.2005
nicht veröffentlicht - nur für den Dienstgebrauch durch die Polizei

4-7 **Facharbeitskreis Probabilistische Sicherheitsanalyse für Kernkraftwerke**:
Methoden zur probabilistischen Sicherheitsanalyse für Kernkraftwerke, BfS-SCHR-37/05
Daten zur probabilistischen Sicherheitsanalyse für Kernkraftwerke, BfS-SCHR-38/05
herausgegeben vom Bundesamt für Strahlenschutz, Oktober 2005

4-8 Beschluss der Ständigen Konferenz der Innenminister und -senatoren der Länder zum Bevölkerungsschutz vom 21. November 2008 (187. Sitzung):
Vereinbarung der Innenminister und -senatoren des Bundes und der Länder und der in der ARD zusammengeschlossenen Rundfunkanstalten sowie des Deutschland Radio über amtliche **Gefahrendurchsagen und Gefahrmitteilungen über das Satellitengestützte Warnsystem des Bundes** (SatWaS) zur Warnung und Information der Bevölkerung bei vorliegenden oder drohenden Gefahren bei Katastrophen und im Verteidigungsfall sowie bei anderen erheblichen Gefahren für die öffentliche Sicherheit

4-9 **Information der Öffentlichkeit über Strahlenrisiken - Krisenkommunikation für Verantwortliche im Katastrophenschutz**, Ausgabe 2008, herausgegeben vom Bundesamt für Bevölkerungsschutz und Katastrophenhilfe (BBK)
Hinweis: Das Dokument ist die deutsche Fassung von Communication Radiation Risks - Crisis Communications for Emergency Responders der United States Environmental Protection Agency (EPA)

4-10 **Leitfaden Katastrophenmedizin - Leitfaden für die ärztliche Versorgung im Katastrophenfall**, 5. überarbeitete Ausgabe 2010, herausgegeben vom Bundesamt für Bevölkerungsschutz und Katastrophenhilfe (BBK)

4-11 **Notfall- und KatastrophenPharmazie**, Ausgabe 2009
Band I: Bevölkerungsschutz und medizinische Notfallversorgung
Band II: Pharmazeutisches Notfallmanagement
herausgegeben vom Bundesamt für Bevölkerungsschutz und Katastrophenhilfe (BBK) und der Deutschen Gesellschaft für KatastrophenMedizin e.V. (DGKM e.V.)

4-12 **Leitfaden zur Information der Öffentlichkeit in kerntechnischen Notfällen,**
Empfehlung der Strahlenschutzkommission (BAnz. 2008. Nr. 152a)
verabschiedet auf der 220. Sitzung der SSK am 05.-06.12.2007
veröffentlicht in der Reihe „Berichte der Strahlenschutzkommission“, Heft 61

5 Standards of the Nuclear Safety Standards Commission (KTA)

Standard No KTA	Title	Issue	Publication in Bundesanzeiger No.	of	Earlier issues	Re-affirmed	Engl. trans-lation
	KTA-interne Verfahrensregeln						
	Begriffe und Definitionen (Begriffesammlung KTA-GS-12) *(KTA Collection of definitions)*	01/10	-		06/91 01/96 01/04 01/06 01/09	-	-
	1200 Allgemeines, Administration, Organisation ***General, administration, organization***						
1201	Anforderungen an das Betriebshandbuch *Requirements for the Operating Manual*	11/09	3 a	07.01.10	02/78 03/81 12/85 06/98	-	-
1202	Anforderungen an das Prüfhandbuch *Requirements for the Testing Manual*	11/09	3 a	07.01.10	06/84	-	-
1203	Anforderungen an das Notfallhandbuch *Requirements for the Emergency Manual*	09/11	3 a	07.01.10	-	-	-
	1300 Radiologischer Arbeitsschutz ***Radiological aspects of industrial safety***						
1301.1 *	Berücksichtigung des Strahlenschutzes der Arbeitskräfte bei Auslegung und Betrieb von Kernkraftwerken; Teil 1: Auslegung *Radiation Protection Considerations for Plant Personnel in the Design and Operation of Nuclear Power Plants; Part 1: Design*	11/84	40 a	27.02.85	-	16.11.04	+
1301.2	Berücksichtigung des Strahlenschutzes der Arbeitskräfte bei Auslegung und Betrieb von Kernkraftwerken; Teil 2: Betrieb *Radiation Protection Considerations for Plant Personnel in the Design and Operation of Nuclear Power Plants; Part 2: Operation*	11/08	15 a	29.01.09	06/82 06/89	-	+
	1400 Qualitätssicherung ***Quality Assurance***						
1401 *	Allgemeine Forderungen an die Qualitätssicherung *General Requirements Regarding Quality Assurance*	06/96	216 a	19.11.96	02/80 12/87	19.06.01	+
1403	Alterungsmangement in Kernkraftwerken *Ageing Management in Nuclear Power Plants*	11/09	178	25.11.09	-	-	-
1404 *	Dokumentation beim Bau und Betrieb von Kernkraftwerken *Documentation During the Construction and Operation of Nuclear Power Plants*	06/01	235 a	15.12.01	06/89	-	+

Standard No KTA	Title	Issue	Publication in Bundesanzeiger No. of	Earlier issues	Re-affirmed	Engl. trans-lation
1408.1	Qualitätssicherung von Schweißzusätzen und -hilfsstoffen für druck- und aktivitäts-führende Komponenten in Kernkraftwerken; Teil 1: Eignungsprüfung *Quality Assurance for Weld Filler Materials and Welding Consumables for Pressure and Activity Retaining Systems in Nuclear Power Plants; Part 1: Qualification Testing*	11/08	15 a 29.01.09	06/85	-	+
1408.2	Qualitätssicherung von Schweißzusätzen und -hilfsstoffen für druck- und aktivitäts-führende Komponenten in Kernkraftwerken; Teil 2: Herstellung *Quality Assurance for Weld Filler Materials and Welding Consumables for Pressure and Activity Retaining Systems in Nuclear Power Plants; Part 2: Manufacture*	11/08	15 a 29.01.09	06/85	-	+
1408.3	Qualitätssicherung von Schweißzusätzen und -hilfsstoffen für druck- und aktivitäts-führende Komponenten in Kernkraftwerken; Teil 3: Verarbeitung *Quality Assurance for Weld Filler Materials and Welding Consumables for Pressure and Activity Retaining Systems in Nuclear Power Plants; Part 3: Processing*	11/08	15 a 29.01.09	06/85	-	+
	1500 Strahlenschutz und Überwachung ***Radiological protection and monitoring***					
1501 *	Ortsfestes System zur Überwachung von Ortsdosisleistungen innerhalb von Kern-kraftwerken *Stationary System for Monitoring the Local Dose Rate within Nuclear Power Plants*	11/04	35 a 19.02.05	10/77 06/91	-	+
1502	Überwachung der Radioaktivität in der Raumluft von Kernkraftwerken *Monitoring Radioactivity in the Inner Atmosphere of Nuclear Power Plants*	11/05	101 a 31.05.06	06/86	-	+
(1502.2)	Überwachung der Radioaktivität in der Raumluft von Kernkraftwerken; Teil 2: Kernkraftwerke mit Hochtemperatur-reaktor *Monitoring Radioactivity in the Inner Atmosphere of Nuclear Power Plants; Part 2: Nuclear Power Plants with High Temperature Reactors*	06/89	229 a 07.12.89	-	-	+
1503.1 *	Überwachung der Ableitung gasförmiger und an Schwebstoffen gebundener radioaktiver Stoffe; Teil 1: Überwachung der Ableitung radio-aktiver Stoffe mit der Kaminfortluft bei bestimmungsgemäßem Betrieb *Surveilling the Release of Gaseous and Aerosol-bound Radioactive Substances; Part 1: Surveilling the Release of Radioactive Substances with the Stack Exhaust Air During Specified Normal Operation*	06/02	172 a 13.09.02 Berichtigung 55 20.03.03	02/79 06/93	13.11.07	+

Standard No KTA	Title	Issue	Publication in Bundesanzeiger No. of	Earlier issues	Re-affirmed	Engl. trans-lation
1503.2 *	Überwachung der Ableitung gasförmiger und aerosolgebundener radioaktiver Stoffe; Teil 2: Überwachung der Ableitung radioaktiver Stoffe mit der Kaminfortluft bei Störfällen *Monitoring the Discharge of Gaseous and Aerosol-bound Radioactive Substances;* *Part 2: Monitoring the Stack Discharge of Radioactive Substances During Design Basis Accidents*	06/99	243 b 23.12.99	-	16.11.04	+
1503.3 *	Überwachung der Ableitung gasförmiger und aerosolgebundener radioaktiver Stoffe; Teil 3: Überwachung der nicht mit der Kaminluft abgeleiteten radioaktiven Stoffe *Monitoring the Discharge of Gaseous and Aerosol-bound Radioactive Substances;* *Part 3: Monitoring the Non-stack Discharge of Radioactive Substances*	06/99	243 b 23.12.99	-	16.11.04	+
1504	Überwachung der Ableitung radioaktiver Stoffe mit Wasser *Monitoring and Assessing of the Discharge of Radioactive Substances in Liquid Effluents*	11/07	9 a 17.01.08	06/78 06/94	-	+
1505 *	Nachweis der Eignung von Strahlungsmesseinrichtungen *Certification of Suitability of Radiation Measuring Equipment*	11/03	26 a 07.02.04	-	-	+
(1506)	Messung der Ortsdosisleistung in Sperrbereichen von Kernkraftwerken (Regel wurde am 16.11.04 zurückgezogen) *Measuring Local Dose Rates in Exclusion Areas of Nuclear Power Plants* *(16.11.2004: standard was withdrawn)*	06/86	162 a 03.09.86 Berichtigung 229 10.12.86	-	16.11.04 zurück-gezogen	-
1507 *	Überwachung der Ableitungen gasförmiger, aerosolgebundener und flüssiger radioaktiver Stoffe bei Forschungsreaktoren *Monitoring the Discharge of Radioactive Substances from Research Reactors*	06/98	172 a 15.09.98	03/84	11.11.03	+
1508	Instrumentierung zur Ermittlung der Ausbreitung radioaktiver Stoffe in der Atmosphäre *Instrumentation for Determining the Dispersion of Radioactive Substances in the Atmosphere*	11/06	245 b 30.12.06	09/88	-	+
	2100 Gesamtanlage ***Plant***					
2101.1 *	Brandschutz in Kernkraftwerken; Teil 1: Grundsätze des Brandschutzes *Fire Protection in Nuclear Power Plants;* *Part 1: Basic Requirements*	12/00	106 a 09.06.01 Berichtigung 239 21.12.07	12/85	22.11.05	+

Standard No KTA	Title	Issue	Publication in Bundesanzeiger No. of	Earlier issues	Re-affirmed	Engl. trans-lation
2101.2 *	Brandschutz in Kernkraftwerken; Teil 2: Brandschutz an baulichen Anlagen *Fire Protection in Nuclear Power Plants; Part 2: Fire Protection of Structural Components*	12/00	106 a 09.06.01	-	22.11.05	+
2101.3 *	Brandschutz in Kernkraftwerken; Teil 3: Brandschutz an maschinen- und elektrotechnischen Anlagen *Fire Protection in Nuclear Power Plants; Part 3: Fire Protection of Mechanical and Electrical Components*	12/00	106 a 09.06.01	-	22.11.05	+
2103	Explosionsschutz in Kernkraftwerken mit Leichtwasserreaktoren (Allgemeine und fallbezogene Anforderungen) *Explosion Protection in Nuclear Power Plants with Light Water Reactors (General and Case-Specific Requirements)*	06/00	231 a 08.12.00	06/89	22.11.05	+
	<u>2200 Einwirkungen von außen</u> ***<u>External events</u>***					
2201.1 *	Auslegung von Kernkraftwerken gegen seismische Einwirkungen; Teil 1: Grundsätze *Design of Nuclear Power Plants against Seismic Events; Part 1: Principles*	06/90	20 a 30.01.91	06/75	20.06.00	+
2201.2 *	Auslegung von Kernkraftwerken gegen seismische Einwirkungen; Teil 2: Baugrund *Design of Nuclear Power Plants against Seismic Events; Part 2: Subsurface Materials (Soil and Rock)*	06/90	20 a 30.01.91	11/82	20.06.00	+
2201.4 *	Auslegung von Kernkraftwerken gegen seismische Einwirkungen; Teil 4: Anforderungen an Verfahren zum Nachweis der Erdbebensicherheit für maschinen- und elektrotechnische Anlagenteile *Design of Nuclear Power Plants against Seismic Events; Part 4: Requirements for Procedures for Verifying the Safety of Mechanical and Electrical Components against Earthquakes*	06/90	20 a 30.01.91 Berichtigung 115 25.06.96	-	20.06.00	+
2201.5 *	Auslegung von Kernkraftwerken gegen seismische Einwirkungen; Teil 5: Seismische Instrumentierung *Design of Nuclear Power Plants against Seismic Events; Part 5: Seismic Instrumentation*	06/96	216 a 19.11.96	06/77 06/90	07.11.06	+
2201.6 *	Auslegung von Kernkraftwerken gegen seismische Einwirkungen; Teil 6: Maßnahmen nach Erdbeben *Design of Nuclear Power Plants against Seismic Events; Part 6: Post-Seismic Measures*	06/92	36 a 23.02.93	-	18.06.02	+

Standard No KTA	Title	Issue	Publication in Bundesanzeiger No.	of	Earlier issues	Re-affirmed	Engl. trans-lation
2206	Auslegung von Kernkraftwerken gegen Blitz-einwirkungen *Design of Nuclear Power Plants Against Damaging Effects from Lightning*	11/09	3 a	07.01.10	06/92 06/00	-	+
2207	Schutz von Kernkraftwerken gegen Hochwasser *Flood Protection for Nuclear Power Plants*	11/04	133 a	16.07.05	06/82 06/92	10.11.09	+
	2500 Bautechnik ***Civil engineering***						
2501 *	Bauwerksabdichtungen von Kernkraftwerken *Structural Waterproofing of Nuclear Power Plants*	11/04	133a	16.07.05	09/88 06/02	-	+
2502 *	Mechanische Auslegung von Brenn-elementlagerbecken in Kernkraftwerken mit Leichtwasserreaktoren *Mechanical Design of Fuel Assembly Storage Pools in Nuclear Power Plants with Light Water Reactors*	06/90	20 a	30.01.91	-	20.06.00	+
	3000 Systeme allgemein ***General systems*** **3100 Reaktorkern und Reaktorregelung** ***Reactor core and reactor control***						
3101.1 *	Auslegung der Reaktorkerne von Druck- und Siedewasserreaktoren; Teil 1: Grundsätze der thermohydraulischen Auslegung *Design of Reactor Cores of Pressurized Water and Boiling Water Reactors;* *Part 1: Principles of Thermohydraulic Design*	02/80	92	20.05.80	-	20.06.00	+
3101.2 *	Auslegung der Reaktorkerne von Druck- und Siedewasserreaktoren; Teil 2: Neutronenphysikalische Anforderun-gen an Auslegung und Betrieb des Reaktor-kerns und der angrenzenden Systeme *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)	Auslegung der Reaktorkerne von gasgekühl-ten Hochtemperaturreaktoren; Teil 1: Berechnung der Helium-Stoffwerte *Reactor Core Design for High Temperature Gas-Cooled Reactors;* *Part 1: Calculation of the Material Properties of Helium*	06/78	189 a	06.10.78	-	15.06.93	+

Standard No KTA	Title	Issue	Publication in Bundesanzeiger No. of	Earlier issues	Re-affirmed	Engl. trans-lation
(3102.2)	Auslegung der Reaktorkerne von gasge-kühlten Hochtemperaturreaktoren; Teil 2: Wärmeübergang im Kugelhaufen *Reactor Core Design for High Temperature Gas-Cooled Reactors;* *Part 2: Heat Transfer in Spherical Fuel Elements*	06/83	194 14.10.83	-	15.06.93	+
(3102.3)	Auslegung der Reaktorkerne von gasge-kühlten Hochtemperaturreaktoren; Teil 3: Reibungsdruckverlust in Kugelhaufen *Reactor Core Design for High Temperature Gas-Cooled Reactors;* *Part 3: Loss of Pressure through Friction in Pebble Bed Cores*	03/81	136 a 28.07.81	-	15.06.93	+
(3102.4)	Auslegung der Reaktorkerne von gasge-kühlten Hochtemperaturreaktoren; Teil 4: Thermohydraulisches Berechnungs-modell für stationäre und quasistationäre Zustände im Kugelhaufen *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 Berichtigung 124 07.07.89	-	15.06.93	+
(3102.5)	Auslegung der Reaktorkerne von gasge-kühlten Hochtemperaturreaktoren; Teil 5: Systematische und statistische Fehler bei der thermohydraulischen Kernauslegung des Kugelhaufenreaktors *Reactor Core Design for High Temperature Gas-Cooled Reactors;* *Part 5: Systematic and Statistical Errors in the Thermohydraulic Core Design of the Pebble Bed Reactor*	06/86	162 a 03.09.86	-	15.06.93	+
3103 *	Abschaltsysteme von Leichtwasserreaktoren *Shutdown Systems for Light Water Reactors*	03/84	145 a 04.08.84	-	15.06.99	+
3104	Ermittlung der Abschaltreaktivität *Determination of the Shutdown Reactivity*	10/79	19 a 29.01.80	-	10.11.09	+
	3200 Primär- und Sekundärkreis ***Primary and secondary circuits***					
3201.1 *	Komponenten des Primärkreises von Leichtwasserreaktoren; Teil 1: Werkstoffe und Erzeugnisformen *Components of the Reactor Coolant Pressure Boundary of Light Water Reactors;* *Part 1: Materials and Product Forms*	06/98	170 a 11.09.98	02/79 11/82 06/90	11.11.03	+
3201.2 *	Komponenten des Primärkreises von Leichtwasserreaktoren; Teil 2: Auslegung, Konstruktion und Berechnung *Components of the Reactor Coolant Pressure Boundary of Light Water Reactors;* *Part 2: Design and Analysis*	06/96	216 a 19.11.96 Berichtigung 129 13.07.00	10/80 03/84	-	+

Standard No KTA	Title	Issue	Publication in Bundesanzeiger No. of	Earlier issues	Re-affirmed	Engl. trans-lation
3201.3	Komponenten des Primärkreises von Leichtwasserreaktoren; Teil 3: Herstellung *Components of the Reactor Coolant Pressure Boundary of Light Water Reactors; Part 3: Manufacture*	01/07	9 a 17.01.08 Berichtigung 82 a 05.06.09	10/79 12/87 06/98	-	+
3201.4 *	Komponenten des Primärkreises von Leichtwasserreaktoren; Teil 4: Wiederkehrende Prüfungen und Betriebsüberwachung *Components of the Reactor Coolant Pressure Boundary of Light Water Reactors; Part 4: Inservice Inspections and Operational Monitoring*	06/99	200 a 22.10.99	06/82 06/90	-	+
3203	Überwachung des Bestrahlungsverhaltens von Werkstoffen der Reaktordruckbehälter von Leichtwasserreaktoren *Surveillance of the Irradiation Behaviour of Reactor Pressure Vessel Materials of LWR Facilities*	06/01	235 a 12.12.01	03/84	07.11.06	+
3204	Reaktordruckbehälter-Einbauten *Reactor Pressure Vessel Internals*	11/08	15 a 29.01.09	03/84 06/98	-	+
3205.1	Komponentenstützkonstruktionen mit nicht-integralen Anschlüssen; Teil 1: Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen für Primärkreis-komponenten in Leichtwasserreaktoren *Component Support Structures with Non-integral Connections; Part 1: Component Support Structures with Non-integral Connections for Components of the Reactor Coolant Pressure Boundary of Light Water Reactors*	06/02	189 a 10.10.02	06/82 06/91	13.07.07	+
3205.2 *	Komponentenstützkonstruktionen mit nicht-integralen Anschlüssen; Teil 2: Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen für druck- und aktivitätsführende Komponenten in Syste-men außerhalb des Primärkreises *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*	06/90	41 a 28.02.91	-	20.06.00	+
3205.3	Komponentenstützkonstruktionen mit nicht-integralen Anschlüssen; Teil 3: Serienmäßige Standardhalterungen *Component Support Structures with Non-integral Connections; Part 3: Series-Production Standard Supports*	11/06	163 31.08.07	06/89	-	+
3211.1 *	Druck- und aktivitätsführende Komponenten von Systemen außerhalb des Primärkreises; Teil 1: Werkstoffe *Pressure and Activity Retaining Components of Systems Outside the Primary Circuit; Part 1: Materials*	06/00	194 a 14.10.00 Berichtigung 132 19.07.01	06/91	-	+

Standard No KTA	Title	Issue	Publication in Bundesanzeiger No. of	Earlier issues	Re-affirmed	Engl. trans-lation
3211.2 *	Druck- und aktivitätsführende Komponenten von Systemen außerhalb des Primärkreises; Teil 2: Auslegung, Konstruktion und Berechnung *Pressure and Activity Retaining Components of Systems Outside the Primary Circuit; Part 2: Design and Analysis*	06/92	165 a 03.09.93 Berichtigung 111 17.06.94	-	-	+
3211.3 *	Druck- und aktivitätsführende Komponenten von Systemen außerhalb des Primärkreises; Teil 3: Herstellung *Pressure and Activity Retaining Components of Systems Outside the Primary Circuit; Part 3: Manufacture*	11/03	26 a 07.02.04	06/90	-	+
3211.4 *	Druck- und aktivitätsführende Komponenten von Systemen außerhalb des Primärkreises; Teil 4: Wiederkehrende Prüfungen und Betriebsüberwachung *Pressure and Activity Retaining Components of Systems Outside the Primary Circuity; Part 4: Inservice Inspections and Operational Monitoring*	06/96	216 a 19.11.96	-	19.06.01	+
	3300 Wärmeabfuhr ***Heat removal***					
3301 *	Nachwärmeabfuhrsysteme von Leichtwasserreaktoren *Residual Heat Removal Systems of Light Water Reactors*	11/84	40 a 27.02.85	-	15.06.99 1)	+
3303 *	Wärmeabfuhrsysteme für Brennelementlagerbecken von Kernkraftwerken mit Leichtwasserreaktoren *Heat Removal Systems for Fuel Assembly Storage Pools in Nuclear Power Plants with Light Water Reactors*	06/90	41 a 28.02.91	-	20.06.00	+
	3400 Sicherheitseinschluss ***Containment***					
3401.1 *	Reaktorsicherheitsbehälter aus Stahl; Teil 1: Werkstoffe und Erzeugnisformen *Steel Containment Vessels; Part 1: Materials*	09/88	37 a 22.02.89	06/80 11/82	16.06.98	+
3401.2	Reaktorsicherheitsbehälter aus Stahl; Teil 2: Auslegung, Konstruktion und Berechnung *Steel Containment Vessels; Part 2: Analysis and Design*	06/85	203 a 29.10.85	06/80	22.11.05	+
3401.3 *	Reaktorsicherheitsbehälter aus Stahl; Teil 3: Herstellung *Steel Containment Vessels; Part 3: Manufacture*	11/86	44 a 05.03.87	10/79	10.06.97	+
3401.4	Reaktorsicherheitsbehälter aus Stahl; Teil 4: Wiederkehrende Prüfungen *Steel Containment Vessels; Part 4: Inservice Inspections*	06/91	7 a 11.01.92	03/81	7.11.06	+

Standard No KTA	Title	Issue	Publication in Bundesanzeiger No.	of	Earlier issues	Re-affirmed	Engl. trans-lation
3402	Schleusen am Reaktorsicherheitsbehälter von Kernkraftwerken – Personenschleusen *Air Locks Through the Containment Vessel of Nuclear Power Plants - Personnel Locks*	11/09	72 a	12.05.10	11/76	-	-
3403 *	Kabeldurchführungen im Reaktorsicherheits-behälter von Kernkraftwerken *Cable Penetrations through the Reactor Containment Vessel*	10/80	44 a	05.03.81	11/76	19.06.01	+
3404	Abschließung der den Reaktorsicherheits-behälter durchdringenden Rohrleitungen von Betriebssystemen im Falle einer Freisetzung von radioaktiven Stoffen in den Reaktor-sicherheitsbehälter *Isolation of Operating System Pipes Penetrating the Containment Vessel in the Case of a Release of Radioactive Substances into the Containment Vessel*	11/08	82 a	05.06.09	09/88	-	-
3405 *	Integrale Leckratenprüfung des Sicherheits-behälters mit der Absolutdruckmethode *Integral Leakage Rate Testing of the Containment Vessel with the Absolute Pressure Method*	02/79	133 a	20.07.79	-	15.06.99	+
3407	Rohrdurchführungen durch den Reaktor-sicherheitsbehälter *Pipe Penetrations through the Reactor Containment Vessel*	06/91	113 a	23.06.92	-	07.11.06	+
3409	Schleusen am Reaktorsicherheitsbehälter von Kernkraftwerken – Materialschleusen *Air-Locks for the Reactor Containment Vessel for Nuclear Power Plants - Material Locks*	11/09	72 a	12.05.10	06/79	-	-
3413	Ermittlung der Belastungen für die Aus-legung des Volldrucksicherheitsbehälters gegen Störfälle innerhalb der Anlage *Determination of Loads for the Design of a Full Pressure Containment Vessel against Plant-Internal Incidents*	06/89	229 a	07.12.89	-	10.11.09	+
	3500 Instrumentierung und Reaktorschutz ***Instrumentations and reactor protection***						
3501 *	Reaktorschutzsystem und Überwachungs-einrichtungen des Sicherheitssystems *Reactor Protection System and Monitoring Equipment of the Safety System*	06/85	203 a	29.10.85	03/77	20.06.00	+
3502 *	Störfallinstrumentierung *Accident Measuring Systems*	06/99	243 b	23.12.99	11/82 11/84	16.11.04	+
3503	Typprüfung von elektrischen Baugruppen des Reaktorschutzsystems *Type Testing of Electrical Modules for the Safety Related Instrumentation and Control System*	11/05	101a	31.05.06	06/82 11/86	-	+

Standard No KTA	Title	Issue	Publication in Bundesanzeiger No.	of	Earlier issues	Re-affirmed	Engl. trans-lation
3504	Elektrische Antriebe des Sicherheitssystems in Kernkraftwerken *Electrical Drive Mechanisms of the Safety System in Nuclear Power Plants*	11/06	245 b	30.12.06	09/88	-	+
3505	Typprüfung von Messwertgebern und Messumformern des Reaktorschutzsystems *Type Testing of Measuring Sensors and Transducers of the Safety-Related Instrumentation and Control System*	11/05	101 a	31.05.06	11/84	-	+
3506 *	Systemprüfung der leittechnischen Einrichtungen des Sicherheitssystems in Kernkraftwerken *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 *	Werksprüfungen, Prüfungen nach Instandsetzung und Nachweis der Betriebsbewährung für leittechnische Einrichtungen des Sicherheitssystems *Factory Tests, Post-repair Tests and Certification of Satisfactory Performance in Service of Modules and Devices for the Instrumentation and Controls of the Safety System*	06/02	27 a	08.02.03	11/86	-	+
	3600 Aktivitätskontrolle und –führung ***Activity control and activity management***						
3601	Lüftungstechnische Anlagen in Kernkraftwerken *Ventilation Systems in Nuclear PowerPlants*	11/05	101 a	31.05.06	06/90	-	+
3602	Lagerung und Handhabung von Brennelementen und zugehörigen Einrichtungen in Kernkraftwerken mit Leichtwasserreaktoren *Storage and Handling of Fuel Assemblies and Associated Items in Nuclear Power Plants with Light Water Reactors*	11/03	26 a	07.02.04	06/82 06/84 06/90	11.11.08	+
3603	Anlagen zur Behandlung von radioaktiv kontaminiertem Wasser in Kernkraftwerken *Facilities for Treating Radioactively Contaminated Water in Nuclear Power Plants*	11/09	3 a	07.01.10	02/80 06/91	-	-
3604	Lagerung, Handhabung und innerbetrieblicher Transport radioaktiver Stoffe (mit Ausnahme von Brennelementen) in Kernkraftwerken *Storage, Handling and Plant-internal Transport of Radioactive Substances in Nuclear Power Plants (with the Exception of Fuel Assemblies)*	11/05	101 a	31.05.06	06/83	-	+

Standard No KTA	Title	Issue	Publication in Bundesanzeiger No.	of	Earlier issues	Re-affirmed	Engl. trans-lation
3605 *	Behandlung radioaktiv kontaminierter Gase in Kernkraftwerken mit Leichtwasser-reaktoren *Treatment of Radioactively Contaminated Gases in Nuclear Power Plants with Light Water Reactors*	06/89	229 a	07.12.89	-	16.11.04	+
	<u>3700 Energie- und Medienversorgung</u> ***<u>Energy and media supply</u>***						
3701 *	Übergeordnete Anforderungen an die elekt-rische Energieversorgung in Kernkraftwerken *General Requirements for the Electrical Power Supply in Nuclear Power Plants*	06/99	243 b	23.12.99	3701.1 (06/78) 3701.2 (06/82) 06/97	16.11.04	+
3702	Notstromerzeugungsanlagen mit Diesel-aggregaten in Kernkraftwerken *Emergency Power Generating Facilities with Diesel-Generator Units in Nuclear Power Plants*	06/00	159 a	24.08.00	3702.1 (06/88) 3702.2 (06/91)	22.11.05	+
3703 *	Notstromanlagen mit Batterien und Gleich-richtergeräten in Kernkraftwerken *Emergency Power Facilities with Batteries and AC/DC Converters in Nuclear Power Plants*	06/99	243 b	23.12.99	06/86	16.11.04	+
3704 *	Notstromanlagen mit Gleichstrom-Wech-selstrom-Umformern in Kernkraftwerken *Emergency Power Facilities with DC/AC Converters in Nuclear Power Plants*	06/99	243 b	23.12.99	06/84	16.11.04	+
3705	Schaltanlagen, Transformatoren und Vertei-lungsnetze zur elektrischen Energieversor-gung des Sicherheitssystems in Kernkraft-werken *Switchgear Facilities, Transformers and Distribution Networks for the Electrical Power Supply of the Safety System in Nuclear Power Plants*	11/06	245 b	30.12.06	09/88 06/99	-	+
3706	Sicherstellung des Erhalts der Kühlmittel-verlust-Störfallfestigkeit von Komponenten der Elektro- und Leittechnik in Betrieb befindlicher Kernkraftwerke *Ensuring the Loss-of-Coolant-Accident Resistance of Electrotechnical Components and of Components in the Instrumentation and Controls of Operating Nuclear Power Plants*	06/00	159 a	24.08.00	-	22.11.05	+
	<u>3900 Systeme, sonstige</u> ***<u>Other systems</u>***						
3901 *	Kommunikationsmittel für Kernkraftwerke *Communication Means for Nuclear Power Plants*	11/04	35 a	19.02.05	03/77 03/81	-	+

Standard No KTA	Title	Issue	Publication in Bundesanzeiger No. of	Earlier issues	Re-affirmed	Engl. trans-lation
3902 *	Auslegung von Hebezeugen in Kernkraft-werken *Design of Lifting Equipment in Nuclear Power Plants*	06/99	144 a 05.08.99	11/75 06/78 11/83 06/92	16.11.04	+
3903 *	Prüfung und Betrieb von Hebezeugen in Kernkraftwerken *Inspection, Testing and Operation of Lifting Equipment in Nuclear Power Plants*	06/99	144 a 05.08.99	11/82 06/93	16.11.04	+
3904	Warte, Notsteuerstelle und örtliche Leit-stände in Kernkraftwerken *Control Room, Remote Shutdown Station and Local Control Stations in Nuclear Power Plants*	11/07	9 a 17.01.08	09/88	-	+
3905 *	Lastanschlagpunkte an Lasten in Kernkraft-werken *Load Attaching Points on Loads in Nuclear Power Plants*	06/99	200 a 22.10.99 Berichtigung 129 13.07.00 136 22.07.00	06/94	-	+

* Standard in revision

( ) Safety Standard related to high temperature reactors are no longer included in the reaffirmation process according to sec. 5.2 of the procedural statutes. Not available at Carl Heymanns Verlag KG.

1) The KTA issued on its 43rd meeting "Instructions for the user of KTA 3301 (11/84)".