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Convention on Nuclear Safety

Report by the Government of the Federal Republic of Germany for the Seventh Review Meeting in March/April 2017

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Division RS I 5 ▪ PO box 12 06 29 ▪ 53048 Bonn ▪ Germany

E-Mail: RSI5@bmub.bund.de

Website: http://www.bmub.bund.de/english

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Abbreviations

AG	*Aktiengesellschaft* Joint-stock company
ALARA	As Low As Reasonably Achievable
ASME	American Society of Mechanical Engineers
AtAV	*Atomrechtliche Abfallverbringungsverordnung* Nuclear Waste Shipment Ordinance
AtDeckV	*Atomrechtliche Deckungsvorsorge-Verordnung* Nuclear Financial Security Ordinance
AtG	*Atomgesetz* Atomic Energy Act
AtKostV	*Kostenverordnung zum AtG* Nuclear Cost Ordinance
AtVfV	*Atomrechtliche Verfahrensverordnung* Nuclear Licensing Procedure Ordinance
AtSMV	*Atomrechtliche Sicherheitsbeauftragten- und Meldeverordnung* Nuclear Safety Officer and Reporting Ordinance
ATWS	Anticipated Transient Without Scram
AtZüV	*Atomrechtlichen Zuverlässigkeitsüberprüfungs-Verordnung* Nuclear Trustworthiness Examination Ordinance
AVR	*Arbeitsgemeinschaft Versuchsreaktor Jülich* Experimental reactor at Jülich
AVT	All Volatile Treatment
AVV	*Allgemeine Verwaltungsvorschrift* General administrative provision
BfE	*Bundesamt für Entsorgung* Federal Office for the Regulation of Nuclear Waste Management
BfS	*Bundesamt für Strahlenschutz* Federal Office for Radiation Protection
BHB	*Betriebshandbuch* Operating manual
BImSchG	*Bundes-Immissionsschutzgesetz* Federal Immission Control Act
BMU	*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (bis Dezember 2013)* Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (until December 2013)
BMUB	*Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (ab Dezember 2013)* Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (as from December 2013)
BMWi	*Bundesministerium für Wirtschaft und Energie* Federal Ministry for Economic Affairs and Energy
BW	Baden-Württemberg
BWR	Boiling Water Reactor

CADAK	OECD/NEA Cable Ageing Data and Knowledge Project
CCF(s)	Common Cause Failure(s)
CNS	Convention on Nuclear Safety
CODAP	OECD/NEA Component Operational Experience, Degradation and Ageing Programme
CONVEX	Convention Exercises
CSS	Commission on Safety Standards
DIN	*Deutsches Institut für Normung* German Institute for Standardization
EAEC	European Atomic Energy Community (also referred to as Euratom)
ECR	Equivalent Cladding Reacted
ECURIE	European Community Urgent Radiological Information Exchange
ELAN	*Elektronische Lagedarstellung* Electronic situation representation
EN	*Europäische Norm* European standard
EnBW	Energie Baden-Württemberg AG
EndlagerVlV	*Endlagervorausleistungsverordnung* Repository Prepayment Ordinance
EnKK	EnBW Kernkraftwerk GmbH
ENSREG	European Nuclear Safety Regulator Group
ERAM	*Endlager für radioaktive Abfälle Morsleben* Morsleben Repository for Radioactive Waste
ESK	*Entsorgungskommission* Nuclear Waste Management Commission
EU	European Union
EURATOM	European Atomic Energy Community (see also EAEC)
e.V.	*Eingetragener Verein* Registered association
FARS	*Fachausschuss Reaktorsicherheit im Länderausschuss für Atomkernenergie (LAA)* Technical Committee for Nuclear Safety of the *Länder* Committee for Nuclear Energy
GfS	Gesellschaft für Simulatorschulung
GG	*Grundgesetz* Basic Law of the Federal Republic of Germany
gGmbH	*Gemeinnützige Gesellschaft mit beschränkter Haftung* Non-profit limited liability company
GKN	*Gemeinschaftskernkraftwerk Neckar* Neckarwestheim nuclear power plant
GmbH	*Gesellschaft mit beschränkter Haftung* Limited liability company
GNSSN	Global Nuclear Safety and Security Network
GNU	*Gesamtnotfallübung* General emergency exercise
GRS	*Gesellschaft für Anlagen- und Reaktorsicherheit gGmbH*
HERCA	Heads of European Radiation Control Authorities

HDR	*Heißdampfreaktor Großwelzheim* Superheated steam reactor, Großwelzheim
HMN	*Handbuch für mitigative Notfallmaßnahmen* Accident mitigation manual
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IEC	International Electrotechnical Commission
IGALL	IAEA Programme on International Generic Ageing Lessons Learned
IMIS	*Integriertes Mess- und Informationssystem zur Überwachung der Umweltradioaktivität* Integrated Measuring and Information System for the Monitoring of Environmental Radioactivity
IMK	*Ständige Konferenz der Innenminister und -senatoren der Länder* Standing Conference of the Interior Ministers and Senators of the *Länder*
IMS	Integrated Management System
INES	International Nuclear and Radiological Event Scale
INEX	International Nuclear Emergency Exercises
INFCIRC	Information Circular
IRRS	Integrated Regulatory Review Service
IRS	International Reporting System on Operating Experiences
IRSRR	Incident Reporting System for Research Reactors
ISO	International Organization for Standardization
KFÜ	*Kernkraftwerks-Fernüberwachungssystem* Remote monitoring system for nuclear power plants
KHG	*Kerntechnische Hilfsdienst GmbH*
KIV	*Kaliumiodid-Verordnung* Potassium iodide ordinance
KKN	*Kernkraftwerk Niederaichbach* Niederaichbach nuclear power plant
KTA	*Kerntechnischer Ausschuss* Nuclear Safety Standards Commission
KWL	*Kernkraftwerk Lingen* Lingen nuclear power plant
KWU	*Kraftwerk Union AG*
LAA	*Länderausschuss für Atomkernenergie* *Länder* Committee for Nuclear Energy
LOCA	Loss-of-coolant accident
MOX	Mixed oxide
MSK scale	Medvedev-Sponheuer-Karnik scale
NaPro	*Programm für eine verantwortungsvolle und sichere Entsorgung bestrahlter Brennelemente und radioaktiver Abfälle (Nationales Entsorgungsprogramm)* Programme for the responsible and safe management of spent fuel and radioactive waste (National Programme)
NGSC	Nuclear Security Guidance Committee
NHB	*Notfallhandbuch* Emergency manual

NUSSC	Nuclear Safety Standards Committee
OECD/NEA	Organisation for Economic Co-operation and Development/Nuclear Energy Agency
OSART	Operational Safety Review Team
PAR	*Passive Autokatalytische Rekombinatoren* Passive autocatalytic recombiners
PBO	*Personelle Betriebsorganisation* Plant personnel organisation
PSA	Probabilistic Safety Analysis
PSÜ	*Periodische Sicherheitsüberprüfung* Periodic Safety Review
PSR	Periodic Safety Review
PWR	Pressurised Water Reactor
RASSC	Radiation Safety Standards Committee
RPV	Reactor Pressure Vessel
Reg-Net	International Regulatory Network
REI	*Richtlinie zur Emissions- und Immissionsüberwachung kerntechnischer Anlagen* Guideline on Emission and Immission Monitoring of Nuclear Installations
RHWG	Reactor Harmonisation Working Group
RODOS	Real-Time Online Decision Support System
RS	Directorate General RS (Safety of Nuclear Installations, Radiological Protection, Nuclear Fuel Cycle) of the BMUB
RSK	*Reaktor-Sicherheitskommission* Reactor Safety Commission
SAMG	Severe Accident Management Guidelines
SBS	*Sicherheitskulturbewertungssystem* Safety culture assessment system
SE	*Sicherer Einschluss* Safe enclosure
SG	*Stilllegungsgenehmigung* Decommissioning licence
SK	*Sicherheit in der Kerntechnik (Fachbereich im BfS)* Nuclear Safety (BfS Department)
SMS	*Sicherheitsmanagementsystem* Safety management system
SSK	*Strahlenschutzkommission* Commission on Radiological Protection
StandAG	*Standortauswahlgesetz* Site Selection Act
StGB	*Strafgesetzbuch* German Criminal Code
StrlSchV	*Strahlenschutzverordnung* Radiation Protection Ordinance
StrVG	*Strahlenschutzvorsorgegesetz* Precautionary Radiological Protection Act
SÜ	*Sicherheitsüberprüfung*

	Safety review
SZL	*Standortzwischenlager* On-site storage facility
TBL	*Transportbehälterlager* Transport cask storage facility
THTR	*Thorium-Hoch-Temperatur-Reaktor* Thorium high-temperature reactor
TRANSSC	Transport Safety Standards Committee
TÜV	*Technischer Überwachungs-Verein* Technical Inspection Agency
UM BW	*Ministerium für Umwelt, Klima und Energiewirtschaft Baden-Württemberg* Ministry of the Environment, Climate Protection and the Energy Sector Baden-Württemberg
UVP	*Umweltverträglichkeitsprüfung* Environmental Impact Assessment (EIA)
UVPG	*Gesetz über die Umweltverträglichkeitsprüfung* Act on the Assessment of Environmental Impacts
VdTÜV	*Verband der Gutachterorganisation der TÜV* Association of Technical Inspection Agencies
VAK	*Versuchsatomkraftwerk Kahl* Experimental nuclear power plant, Kahl
VGB	VGB PowerTech e. V., formerly “Technische Vereinigung der Großkraftwerksbetreiber”
VGB-SBS	*VGB-Sicherheitskulturbewertungssystem* VGB safety culture assessment system
VGB-ZMA	*Zentrale Melde- und Auswertungsstelle des VGB* Central Incident Reporting and Evaluation Office of VGB
WAK	*Wiederaufarbeitungsanlage Karlsruhe* Karlsruhe reprocessing plant
WANO	World Association of Nuclear Operators
WASSC	Waste Safety Standards Committee
WENRA	Western European Nuclear Regulators Association
WGE	Working Group Emergencies
WLN	*Weiterleitungsnachricht* Information notice
ZdB	*Zentralstelle des Bundes* Central Federal Agency

Introduction

In accordance with Article 2 para. i of the Convention text, this report uses the term “nuclear installation” for each land-based civil nuclear power plant under German jurisdiction including such storage, handling and treatment facilities for radioactive materials as are on the same site and are directly related to the operation of the nuclear power plant. The term “post operation” of a nuclear installation covers the period between final cessation of power and production operation for electricity generation of the nuclear installation and the utilisation of an enforceable licence for decommissioning, safe enclosure or dismantling according to § 7 para. 3 of the Atomic Energy Act (AtG) [1A-3] by the licence holder. Furthermore, this report uses the collective term “nuclear facilities”, which comprises nuclear installations, research reactors with more than 50 kW thermal power, nuclear fuel cycle facilities, nuclear installations under decommissioning and storage facilities for spent fuel.

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

As a legal basis for the operation of the German nuclear installations, the AtG was amended in 2002 with the aim to phase out the use of nuclear energy for the commercial generation of electricity in a controlled and structured manner. The Act laid down the electricity production rights for each nuclear installation. With the amendment of the AtG of 6 August 2011 *(13th AtG amendment*[1]*)*, further operation of eight nuclear installations for electricity generation (power operation) was terminated, whereas additional dates for the latest possible termination of power operation were fixed for the remaining nine nuclear installations.

Nuclear installations in Germany

The first nuclear installation was commissioned in Germany in the years 1960/61, the last commissioning of a nuclear installation was in the years 1988/89. Currently, eight nuclear installations are operated for electricity generation in Germany. Overall, Germany has 18 nuclear installations as defined by the Convention (→ Figure 6-2). Moreover, seven research and training reactors are in operation.

The Federal Republic of Germany's reaction to the nuclear accident at Fukushima

Immediately after the nuclear accident at Fukushima, an intensive socio-political debate began in Germany about the future peaceful use of nuclear energy as well as about the lessons to be learned from the accident.

As a first reaction, the Federal Government and the minister-presidents of the *Länder* where nuclear installations are located jointly decided on 14 March 2011 that the safety of all nuclear installations in Germany should be reviewed in the light of the events of the nuclear accident at Fukushima.

In 2011, the then Federal Environment Ministry (BMU) requested the Reactor Safety Commission (RSK) to assess the plant-specific safety of all nuclear installations. For this purpose, the RSK pre-

1 13th Act amending the Atomic Energy Act, Federal Law Gazette, 31 July 2011

pared a *catalogue of requirements*[2]. For the review of the German nuclear installations, the analyses concentrated in particular on whether and to what extent the main safety functions “control of reactivity” (subcriticality), “fuel cooling” (in the reactor pressure vessel and in the spent fuel pool) and “confinement of the radioactive material” (maintenance of barrier integrity) will be fulfilled in case of external hazards that go beyond the impacts considered in the design so far (robustness assessment). The related investigations conducted by the RSK focussed on seismic and flooding events with postulated failures (e.g. long-lasting loss of offsite power, complete loss of AC power supply and emergency power supply, loss of service water supply) and preventive and emergency measures under aggravated boundary conditions. Moreover, additional man-made hazards, such as aircraft crash, blast waves or terrorist attacks, and potential impacts from neighbouring units were examined.

In its *statement SÜ*[3] (safety review) of 16 May 2011, the RSK came to the summarising conclusion that compared with the nuclear installations in Fukushima, a higher level of precaution can be ascertained for German nuclear installations with regard to electrical power supply and the consideration of flooding events: “*The assessment of the nuclear power plants regarding the selected impacts shows that for the topic areas considered, there is no general result for all plants in dependence of type, age of the plant, and generation. The existing plant-specific design differences according to the current state of licensing were only partially considered by the RSK. Plants that originally had a less robust design were backfitted with partly autonomous emergency systems to ensure vital functions. In the robustness assessment performed here, this selectively leads to evidentially high degrees of robustness.*”

Besides the technical discussions in the RSK regarding the nuclear accident at Fukushima and the consequences for the nuclear installations in Germany, the socio-political aspects were discussed within the Ethics Commission for a Safe Energy Supply, set up by the Federal Government in April 2011, and the results published on 30 May 2011. On 6 June 2011, the Federal Government adopted a draft law to amend the AtG, taking into account the findings of the RSK and the *report of the Ethics Commission*[4], according to which eight nuclear installations lost their authorisation for power operation. It was also decided that the remaining nine nuclear installations should be permanently shut down step by step by the end of the year 2022. The amended AtG (13th AtG amendment) entered into force on 6 August 2011. The Government of the Federal Republic of Germany commented on this issue in detail in the report for the Sixth Review Meeting under the Convention on Nuclear Safety in March/April 2014.

National Action Plan for the implementation of measures after the Fukushima accident

After the nuclear accident at Fukushima, actions were initiated in Germany to review the safety of the German nuclear installations. Based on RSK recommendations and on behalf of the then Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH prepared an information notice *WLN 2012/02*[5]. A National Action Plan, which is published annually and updated on the website of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), summarises the main activities after the Fukushima accident.

2 “Anforderungskatalog für anlagenbezogene Überprüfungen deutscher Kernkraftwerke unter Berücksichtigung der Ereignisse in Fukushima-I (Japan)”, adopted at the 434th RSK meeting on 30 March 2011

3 RSK statement: “Anlagenspezifische Sicherheitsüberprüfung (RSK-SÜ) deutscher Kernkraftwerke unter Berücksichtigung der Ereignisse in Fukushima-I (Japan)”, adopted at the 437th RSK meeting on 11-14 May 2011

4 “Germany’s energy transition – a collective project for the future”, Ethics Commission for a Safe Energy Supply, Berlin, 30 May 2011

5 “Auswirkungen des Tohoku-Erdbebens an den japanischen Kernkraftwerksstandorten Fukushima Dai-ichi (I) und Dai-ni (II) am 11. März 2011 und des Niigataken Chuetsu-Oki-Erdbebens am japanischen Kernkraftwerksstandort Kashiwazaki-Kariwa am 16. Juli 2007”, information notice WLN 2012/02, 15 February 2012

This National Action Plan contains the plant-specific status of the activities and measures planned and already implemented in response to the above information notice "WLN 2012/02" of GRS and the specific statements and recommendations of the RSK:

- RSK statement: Plant-specific safety review (RSK-SÜ) of German research reactors in the light of the events in Fukushima-I (Japan), (447th RSK meeting on 3 May 2012)
- RSK statement: Loss of the primary ultimate heat sink, (446th RSK meeting on 5 April 2012)
- RSK recommendation: Recommendations of the RSK on the robustness of the German nuclear power plants, (450th RSK meeting on 26/27 September 2012)
- RSK statement: Minimum value of 0.1g (approx. 1.0 m/s²) for the maximum horizontal ground acceleration in an earthquake, (457th RSK meeting on 11 April 2013)
- RSK statement: Assessment of the coverage of extreme weather conditions by the existing design, (462nd RSK meeting on 6 November 2013)
- RSK recommendation: Hydrogen release from the containment,
(475th RSK meeting on 15 April 2015)

General challenges of the Sixth Review Meeting

Under item 35 of the "*Summary Report*"[6] of the Sixth Review Meeting, five general challenges are listed based on the observations of the Special Rapporteur for consideration of the contracting parties in the next national reports under the Convention on Nuclear Safety (CNS). Furthermore, the President of the Seventh Review Meeting requests all contracting parties in his guidance letter to report on the consideration of these general challenges. The Federal Republic of Germany comments on these challenges as follows:

"How to minimize gaps between Contracting Parties' safety improvement?"

The AtG stipulates that the necessary precautions have to be taken in the light of the state of the art in science and technology to prevent damage resulting from the erection and operation of a nuclear installation. The state of the art in science and technology is also determined by international developments. Therefore, Germany keeps track of developments in the field of nuclear safety by participating in committees, by evaluating the results of studies carried out by relevant (inter-)national, multi- and bilateral bodies and institutions, rules and regulations, and from other specialist contacts and the specialist literature. Germany actively participates in the activities and projects for the development of safety standards of the IAEA (International Atomic Energy Agency) as well as of the OECD/NEA (Organisation for Economic Co-operation and Development/Nuclear Energy Agency) that are necessary in terms of safety. At the European level, the developments aimed at enhancing nuclear safety by the European Commission and the discussions and debates within the ENSREG (European Nuclear Safety Regulator Group) and WENRA (Western European Nuclear Regulators Association) are followed. In this respect, there is a lively exchange between the European supervisory authorities also regarding the implementation of backfitting measures in particular as a result of the EU stress tests. International benchmarking that goes beyond the mere exchange of information to implement backfitting measures can at least advance the technical discussion on the safety assessments of backfitting measures and contribute to the minimisation of distances between the contracting parties.

German expertise and practice is introduced into the international discussion within the framework of international working groups as well as bilateral meetings and commissions. In addition, the

6 "6th Review Meeting of the Contracting Parties to the Convention on Nuclear Safety - Summary Report", CNS/6RM/2014/11_Final, 4 April 2014

BMUB requests its advisory commissions RSK, Nuclear Waste Management Commission (ESK) and Commission on Radiological Protection (SSK) to comment on selected developments in the area of nuclear safety and to make recommendations. The expert organisation GRS supports the BMUB by drawing up recommendations in the form of information notices (WLN) following the evaluation of events that occurred in German but also in foreign nuclear installations. Within the framework of the licensing and supervisory procedures, the licensing and supervisory authorities of the *Länder* review new findings obtained this way, in particular for plant-specific relevance. They decide whether, and if so, what action is needed in the particular case and initiate measures if required. Depending on the assessment, in the medium to longer term, new findings will be considered for amendments to the "Safety Requirements for Nuclear Power Plants", for the review of safety standards of the Nuclear Safety Standards Commission (KTA) and for drawing up further guidelines.

"How to achieve harmonized emergency plans and response measures?"

Immediately after the nuclear accident at Fukushima it showed that the contracting parties to the CNS partly gave different recommendations to their citizens in Japan regarding precautionary radiation protection. In addition to other discussions, such as on the lessons learned from the Fukushima accident, internationally this led to intensified discussions with the objective to further harmonise the preventive and emergency measures. In Europe, Germany participated in the development of proposals for harmonisation of off-site emergency preparedness and response within the WENRA and HERCA (Heads of European Radiation Control Authorities). In 2014, HERCA and WENRA jointly adopted a position paper on cross-border emergency preparedness. This paper includes a standardised scheme for assessing the state of nuclear installations. Moreover, for the first time, cross-border recommendations are given on initial measures in the event of severe accidents in nuclear installations. With the recommendations, a robust classification can be made on the basis of a very limited number of plant and weather parameters that are available even in worst-case scenarios and are deliberately limited to the primary countermeasures: evacuation, sheltering and stable iodine prophylaxis. The planning zones largely correspond to the recommendations issued by the SSK and which are currently being implemented in Germany by the competent authorities. The German approach to stable iodine prophylaxis goes beyond the new European standard inasmuch as this action is to be planned for children, young adults and pregnant women throughout the country and not only within a radius of 100 km around nuclear installations.

The WENRA-HERCA approach is the way agreed upon by the European Union (EU) countries to act in the field of civil protection in future. It would be conceivable to pursue this process also beyond EU borders.

"How to make better use of operating and regulatory experience, and international peer review services?"

Germany is involved in various international activities for the exchange of operating experience. These include the activities of the INES officer (International Nuclear and Radiological Event Scale Officer) and the participation in the Incident Reporting System (IRS) and Incident Reporting System for Research Reactors (IRSRR). For this purpose, GRS processes reports from German nuclear installations and evaluates events in foreign nuclear installations with regard to their applicability to German installations. Other activities include the participation in the IGALL project of the IAEA and the database projects CODAP and CADAK of the OECD/NEA (see "Abbreviations" for meaning of abbreviations). As stipulated in Council Directive 2009/71/EURATOM, amended by Council Directive 2014/87/EURATOM, an IRRS mission (Integrated Regulatory Review Service Mission) is conducted in Germany every ten years. Staff of German authorities occasionally also participate in IRRS missions as experts at foreign authorities. At German nuclear installations, WANO (World Association of Nuclear Operators) peer reviews are conducted on a regular basis. At the invitation of the Federal Government, OSART (Operational Safety Review Team) missions are conducted by the IAEA. In addition, Germany is actively involved in various peer reviews at the European level, such as the ENSREG stress test and the peer reviews provided on the basis of

Council Directive 2014/87/EURATOM to mutually assess the implementation of the national action plans as well as the topical peer reviews or, currently, the benchmarking process within the WENRA (self-assessment process) regarding the status of implementation of “WENRA Safety Reference levels” in the national rules and regulations.

The results of operating experience and evaluation of international events in countries with many nuclear installations and a wealth of experience could be made available to all contracting parties to the CNS. The IAEA could increasingly distribute the evaluations and send them to countries with similar reactors.

“How to improve regulators’ independence, safety culture, transparency and openness?”

Article 8 (2) of this national report describes how independence of the nuclear licensing and supervisory authorities of the Federation and the *Länder* from the licence holders of the nuclear installations is ensured. Independence from negative influences from the industry can be ensured if governments recognise and assume their ultimate responsibility for nuclear safety. In this respect, safety aspects are to be given priority over economic interests. The essential basis for safety culture is that the respective management level gives clear signals to the staff that this prioritisation is supported unequivocally in any decisions at the management level. On this basis, honesty, trust and openness can be lived as central elements of a safety culture.

Furthermore, it is described which measures have been taken to improve the transparency of activities of the nuclear licensing and supervisory authorities. So far, the BMUB and the competent nuclear licensing and supervisory authorities of the *Länder* mainly used their own websites for fulfilling their obligations to provide information. In order to allow citizens easier access to this information, an online information portal of the Federation and the *Länder* on safety in nuclear technology is to provide an opportunity to make relevant information available on the Internet via a central website. In addition to information on nuclear installations in Germany and on emergency preparedness and response, it is intended to prepare and provide other relevant information via the joint online portal. This includes an overview of the regulatory system in Germany, European and international activities of the German nuclear licensing and supervisory authorities as well as basic knowledge of nuclear technology.

“How to engage all countries to commit and participate in international co-operation?”

Germany is intensely involved in both multilateral and bilateral cooperation. It is represented in all bodies developing IAEA safety standards and also actively participates in the development of safety standards that are of significance from the German perspective. Germany is also represented in many bodies of the OECD/NEA that are related to nuclear safety or holds the chair of such body or its working groups. At the European level, multilateral cooperation exists within the framework of ENSREG, WENRA and HERCA. There are bilateral commissions with almost all neighbouring states that operate nuclear installations. Meanwhile, a bilateral commission has also been initiated by Belgium and Germany. Moreover, there is also a regular bilateral exchange between nuclear experts from Austria and Germany.

States that are already contracting party to the Convention on Nuclear Safety could take on “regulatory sponsorships” for states that are at the beginning of using nuclear power for energy generation.

Obligations of the Federal Republic of Germany under the Convention on Nuclear Safety and overview 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 installations nationally and worldwide. Continuously ensuring and enhancing the safety of the nuclear installations in operation must be given highest priority. Regardless of the position of the Federal Government on the necessity of the use of nuclear energy for the commercial generation of electricity, 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 update of the "Safety Requirements for Nuclear Power Plants" published in 2012 [3-0.1] and their "Interpretations" [3-0.2] in March 2015, the participation in the revision of the "*WENRA Safety Reference Levels*"[7] and the continued discussions in the Reactor Harmonisation Working Group (RHWG) and at the national level (e.g. self-assessment 2015/2016). The aim is to implement the new "WENRA Safety Reference Levels" in the national rules and regulations – insofar as this has not already been done – by the year 2017.

In 2015, the KTA Steering Committee decided that by 2017/2018, revision and updating of all KTA safety standards (→ Articles 6 and 7) are to be completed. This is to ensure that, according to the KTA statutes, the standards will be applicable by 2022, which is the deadline laid down by law for the termination of power operation of the last nuclear installation in Germany.

At the same time, adaptation of the KTA safety standards to the "Safety Requirements for Nuclear Power Plants" will be continued and is also to be completed by 2017/2018.

Preparation of the report

Contributors to the seventh report of the Government of the Federal Republic of Germany under the Convention on Nuclear Safety were those organisations in Germany that are concerned with the safety of nuclear installations. These are, in particular, the nuclear licensing and supervisory authorities of the Federation and their expert organisation, the nuclear licensing and supervisory authorities of the *Länder* as well as the Technical Association of Large Power Plant Operators (VGB PowerTech e.V. – Nuclear Power Plants – VGB), which represents the four power utilities that operate nuclear installations in Germany.

This report follows the provisions of guideline *INFCIRC/572 Rev. 5*[8] in terms of content.

The terms used in this report for the designation of certain functions refer to both female and male persons.

This report has been conceived as a complete and closed representation and does therefore not merely confine itself to the changes since the Sixth Review Meeting.

Even though research reactors are not nuclear installations as defined by the Convention, information on research reactors has been included, as in the previous reports, in Article 6 and in Appendix 2.

To demonstrate compliance with the obligations, the relevant laws, ordinances and regulations are indicated for each article of the Convention. In each article it is described how the essential safety requirements are fulfilled in the nuclear installations and what measures have been taken by the licence holders of the nuclear installations. The seventh national report focusses on the licensing procedure and regulatory supervision, the measures taken to improve nuclear safety and in particular the results and provisions of the "*Vienna Declaration on Nuclear Safety*"[9].

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7 WENRA Safety Reference Levels for Existing Reactors - Update in Relation to Lessons Learned from Tepco Fukushima Dai-Ichi Accident, 24 September 2014, www.wenra.org/media/filer_public/2014/09/19/wenra_safety_reference_level_for_existing_reactors_september_2014.pdf

8 "Guidelines Regarding National Reports under the Convention on Nuclear Safety", IAEA, 16 January 2015

9 "Vienna Declaration on Nuclear Safety - On principles for the implementation of the objective of the Convention on Nuclear Safety to prevent accidents and mitigate radiological consequences", Vienna, 9 February 2015

At the request of the contracting parties at the Sixth Review Meeting in 2014, a group of experts has dealt with the question of how and in what way a concrete consideration of and compliance with the IAEA Safety Requirements and parts of the Safety Fundamentals can be ensured in the national reports of the contracting parties in accordance with guideline INFCIRC 572 as regards siting (→ Article 17) and design and construction (→ Article 18). The expert group submitted a report on this issue ("Template to support the drafting of National Reports under the Convention on Nuclear Safety referring to relevant IAEA Safety Requirements") and asked for application on a "voluntary basis". Since in Germany nuclear installations for electricity generation are no longer built and the existing nuclear installations will be permanently shut down by 2022, the application of the "Template" in the said articles of the national report does not seem to be useful in terms of safety. It was already stated in the *national report for the Sixth Review Meeting*[10] that the "Safety Requirements for Nuclear Power Plants", published in 2012, have been developed taking into account the IAEA Safety Requirements and Safety Fundamentals. A special and interactive *guide to the Safety Requirements*[11] was created in 2014 and updated in 2015 to facilitate the application of the "Safety Requirements for Nuclear Power Plants" and their "Interpretations", which, among other things, shows the relations of the safety requirements to the IAEA safety standards.

The appendices to this report contain a list of nuclear installations and research reactors in operation and under decommissioning, a compilation of the design basis and beyond-design-basis accidents to be considered in the safety reviews, an overview of the safety-relevant features of the nuclear installations (as defined by the Convention) itemised by type and construction line, a comprehensive list of the legal provisions, administrative provisions, nuclear rules and guidelines that are relevant to the safety of the nuclear installations as defined by the Convention and that are referred to in the report as well as a list of plant-specific activities and measures in German nuclear installations in the wake of the Fukushima accident.

The German report is mainly based on

- the results of the sixth and previous review meetings,
- the results of the second extraordinary meeting of August 2012 (Fukushima),
- the focal points of the questions posed to Germany on the occasion of the Sixth Review Meeting, and
- the results of the consultations within Country Group 6 (CG 6) of the Sixth Review Meeting.

The report of Germany as contracting party was approved by the Cabinet of Ministers of the Federal Government at its meeting on 22 June 2016.

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10 Convention on Nuclear Safety – Report by the Government of the Federal Republic of Germany for the Sixth Review Meeting in March/April 2014, BMU, 26 June 2013, http://www.bmub.bund.de/fileadmin/Daten_BMU/Pools/Broschueren/bericht_uebereinkommen_nukl_sicherheit__en_bf.pdf

11 "Wegweiser zu den Sicherheitsanforderungen an Kernkraftwerke (SiAnf)" of 2015, http://regelwerk.grs.de/de/Wegweiser

Summary of the main results since the Sixth Review Meeting

In the following, the main results and activities in the field of ensuring nuclear safety since the Sixth Review Meeting in 2014 are presented

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. Hence, the further development of the challenges identified for Germany at the Sixth Review Meeting in 2014 will also be reported below (reference to the respective articles of the 7th national report indicated in parentheses):

Challenge 1 Complete implementation of the National Action Plan in response to the Fukushima accident (→ Article 14)

Challenge 2 Transfer of nuclear installations permanently shut down into decommissioning (→ Article 14)

Challenge 3 Addressing the issues that can arise in the application of the new "Safety Requirements for Nuclear Power Plants" in the existing nuclear installations (→ Article 19)

Challenge 4 Enhancing the transparency of the activities of the nuclear licensing and supervisory authorities of the Federation and the *Länder* (→ Article 8)

Challenge 5 Continued development and update of emergency plans and emergency criteria, including return of evacuees (→ Article 16)

Challenge 6 Close monitoring of the impact of the phase-out decision on the personnel situation in the nuclear installations and taking of proactive measures to ensure appropriate working climate and safety culture (→ Article 11)

Challenge 7 Achievement of a common understanding of regulatory tasks and functions in terms of monitoring and supervision at the different organisations involved and clarification of the interfaces, information transfer and communication needs (→ Article 8)

According to the 13th AtG amendment, entered into force on 6 August 2011, the use of nuclear energy for the commercial generation of electricity will be terminated in Germany by the end of 2022 at the latest. Regardless of the phase-out decision, the Federal Government enforces the necessary framework to ensure a high level of safety of the remaining nuclear installations in Germany.

Council Directive 2011/70/EURATOM [1F-3.19] of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste was to be transposed into national law in the member states. The accordingly amended AtG entered into force on 20 November 2015 (*14th AtG amendment*[12]). This Act lays down the obligation to draw up a *National Programme*"[13] (NaPro) describing the national strategy for the responsible and safe management of spent fuel and radioactive waste.

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12 14th Act amending the Atomic Energy Act, Federal Law Gazette, 20 November 2015

13 "Programm für eine verantwortungsvolle und sichere Entsorgung bestrahlter Brennelemente und radioaktiver Abfälle (Nationales Entsorgungsprogramm)", BMUB, August 2015

Measures taken in the wake of the Fukushima accident

Both the results of the *EU stress test*[14] and the national reviews showed that the German nuclear installations as defined by the Convention partly even have substantial safety margins (high robustness). This is also due to the additional safety-enhancing preventive and backfitting measures continuously implemented in the past.

In order to implement all recommendations and suggestions from the RSK statement on the plant-specific safety review (RSK-SÜ), measures of the nuclear licensing and supervisory authorities of the *Länder*, information notice "WLN 2012/02" of GRS, the EU stress test and the second extraordinary CNS meeting, a *National Action Plan*[15] was drawn up for the implementation of measures after the nuclear accident at Fukushima. During the reporting period after the Sixth Review Meeting, the National Action Plan has been updated several times and published by the BMUB as "*Updated German Action Plan*"[16] in March 2016 (third update). The contents of this Action Plan concern safety improvements to further increase the robustness in the beyond-design-basis area and are mainly related to electric power supply, residual heat removal and emergency preparedness and response. In Article 14, several actions are explained as an example. A tabular list of the plant-specific actions under the Action Plan is set out in the Appendix 6. The complete Action Plan was published on the Internet on the BMUB website www.bmub.bund.de (in German) and on www.ensreg.eu (in English).

Within the framework of the EU stress tests, the nuclear licensing and supervisory authorities of the *Länder* confirmed that there are no design deficiencies in the German nuclear installations and precautions have been taken in all German nuclear installations as are necessary in accordance with the AtG in the light of the state of the art in science and technology in order to prevent damage. The implementation of additional measures is carried out by the licence holders of the nuclear installations within the nuclear licensing and supervisory procedures of the *Länder*.

Further backfitting measures and improvements

The level of safety of the German nuclear installations is to be maintained or improved by continual backfitting. Since the national report for the Sixth Review Meeting, various measures have been carried out in this respect. Examples are

- preventive emergency measures that have been implemented for all installations in power operation,
- an accident mitigation manual (HMN) that was prepared for the crisis team, and
- robustness analyses for the beyond-design-basis area that were carried out by the licence holders.

These measures are described in Article 14 in detail.

Safety requirements and regulations

In the period from 2013 to 2015, the RSK published a total of six recommendations and twelve statements on important safety issues. The recommendations addressed the following:

- Faults in one or two phases of the main, standby or emergency grid connection

14 "Joint Declearation on stress tests", "EU stress tests specifications", https://ec.europa.eu/energy/en/topics/nuclear-energy/nuclear-safety/stress-tests

15 "Aktionsplan zur Umsetzung von Maßnahmen nach dem Reaktorunfall in Fukushima", BMU, 3 December 2012

16 "Fortgeschriebener Aktionsplan zur Umsetzung von Maßnahmen nach dem Reaktorunfall in Fukushima", BMUB, March 2016

- Basic recommendations for the planning of emergency control measures by the operators of nuclear power plants
- Guideline for the performance of integrated event analyses
- Hydrogen release from the containment
- Demonstration of residual ductility/residual strength using an equivalent cladding reacted (ECR) criterion
- Requirements for spent fuel pool cooling

Statements were prepared on the following issues:

- Flaws in the reactor pressure vessel (RPV) of the Belgian nuclear power plant Doel, Unit 3 (Doel-3)
- Pressure and leak tests of components of the reactor coolant pressure boundary and outer systems, especially after repairs
- Minimum value of 0.1g (approx. 1.0 m/s²) for the maximum horizontal ground acceleration in an earthquake
- Neutron flux oscillations in pressurised water reactors (PWRs)
- Specification of requirements related to the 10-hours self-sufficiency in the event of external man-made hazards (man-made hazard conditions)
- RSK's understanding of safety philosophy
- Assessment of the coverage of extreme weather conditions by the existing design
- RSK guideline for the implementation of integrated event analyses in comparison with the VGB guideline on the integrated event analysis
- Formation and effects of an unborated water plug during steam generator tube rupture
- Section-wide unavailabilities due to electrical coupling between redundant sections of the emergency power system of German nuclear installations
- Deformations of fuel assemblies in German PWRs
- Requirements for LOCA analyses by statistical methods

Article 6 includes further details on selected topics.

The KTA safety standards are regularly reviewed for validity. In February 2016, the KTA programme of standards comprised 97 standards. 90 of them are applicable KTA safety standards, and seven are standards which are no longer subjected to regular reviews. 24 of the 97 standards are currently in the revision process.

The *methods and data volume for the probabilistic safety analysis for nuclear power plants*[17] is reviewed and amended, where required, regarding the topics of low-power and shutdown states, personnel actions, external hazards and probabilistic safety analyses (PSAs) of Level 2.

With the experts from nuclear licensing and supervisory authorities and expert organisations, Germany continues to participate in the further development of international nuclear rules and regulations. In particular, Germany participated by

17 Working group of PSA experts (FAK PSA) for nuclear power plants:
Methoden zur probabilistischen Sicherheitsanalyse für Kernkraftwerke, BfS-SCHR-37/05, urn:nbn:de:0221-201011243824
Daten zur probabilistischen Sicherheitsanalyse für Kernkraftwerke, BfS-SCHR-38/05, urn:nbn:de:0221-2010112433838
published by the Federal Office for Radiation Protection (BfS), October 2005

- active involvement in all IAEA safety standards committees
  - CSS (Commission on Safety Standards),
  - NUSSC (Nuclear Safety Standards Committee),
  - WASSC (Waste Safety Standards Committee),
  - RASSC (Radiation Safety Standards Committee),
  - TRANSSC (Transport Safety Standards Committee), and
  - NGSC (Nuclear Security Guidance Committee), or
- by funding and secondment of German technical experts for the development and revision of the IAEA general safety requirements" and the IAEA safety standards.

This way, Germany is making an active contribution to the international harmonisation of safety requirements. Since 2006, the IAEA's rule-making activities have been summarised in an annual BMUB report provided to the nuclear licensing and supervisory authorities of the *Länder*, their authorised experts and the general public. A comparison of the national nuclear rules and regulations with the current IAEA safety standards was also prepared and is continually updated.

For nuclear installations in the post-operational phase, the *Länder* Committee for Nuclear Energy (LAA) decided that the licence holder has to perform a safety analysis for this phase.

Based on the recommendations of the IRRS mission in 2008, the processes and interfaces of the nuclear licensing and supervisory authorities of the Federation and the *Länder* were compiled in a handbook on cooperation between the Federation and the *Länder* in nuclear law, which is expected to be adopted in 2016.

During the reporting period, Germany has begun comparing the recommendations of the NEA Regulatory Guidance Booklets with the applicable national nuclear rules and regulations within the framework of its membership in the OECD/NEA. The result of the review of the booklet "Regulatory Challenges in Using Nuclear Operating Experience" was presented in the LAA at the 65th meeting of the Technical Committee for Nuclear Safety (FARS). It showed that the supervisory practices of the German nuclear licensing and supervisory authorities largely comply with the recommendations of the OECD/NEA.

Radiation protection

During the reporting period, the "Safety Requirements for Nuclear Power Plants" published in 2012, which also summarise the radiation protection requirements for nuclear installations, were revised (March 2015). The "Interpretations" on the "Safety Requirements for Nuclear Power Plants" were also revised in March 2015. One of these interpretations specifies the requirements relating to radiation protection.

In addition, the guideline relating to the technical qualification of radiation protection officers at installations for the fission of nuclear fuel has been revised and was published in 2014. Furthermore, several KTA safety standards with relevance for radiation protection have been updated.

Emergency preparedness and response

Since 2014, numerous regulatory documents related to emergency preparedness have been newly prepared or amended during the reporting period.

Against the background of the nuclear accident at Fukushima, the BMU requested the SSK in June 2011 to carry out a review of the national nuclear rules and regulations regarding off-site nuclear emergency preparedness. The *Länder* took part in the corresponding working groups at the Federation-*Länder* level. The results of the consultations, which lasted for more than three years, have been considered i.a. in the new and revised regulations:

- SSK recommendation: Further development of emergency response through implementation of the lessons learned from Fukushima, (274th SSK meeting on 19/20 February 2015)
- SSK recommendation: Basic recommendations for emergency protection in the vicinity of nuclear power plants, (274th SSK meeting on 19/20 February 2015)
- SSK recommendation: Basic radiological principles for decisions on measures for the protection of the population against incidents involving releases of radionuclides, (268th SSK meeting on 13/14 February 2014)
- SSK recommendation: Planning areas for emergency response near nuclear power plants, (268th SSK meeting on 13/14 February 2014)
- SSK recommendation: Planning areas for emergency response near decommissioned nuclear power plants, (271st SSK meeting on 20/21 October 2014)
- SSK recommendation: Planning iodine thyroid blocking in the vicinity of decommissioned nuclear power plants, (269th SSK meeting on 10 April 2014)
- SSK recommendation: Prognosis and estimation of source terms in connection with nuclear power plant accidents, (270th SSK meeting on 17/18 July 2014)
- SSK statement: Issues relating to the organisation and operation of emergency care centres, (268th SSK meeting on 13 February 2014)
- Basic recommendation on the establishment and operation of emergency care centres
- RSK/SSK basic recommendations: Planning of emergency control measures by the operators of nuclear power plants, (468th RSK meeting on 4 September 2014 and 271st SSK meeting on 21 October 2014)
- RSK/SSK recommendation: Criteria for alerting the disaster control authority by the operators of nuclear installations, (453rd RSK meeting on 13 December 2012 and 260th SSK meeting on 28 February 2013)

The planning areas in particular and the associated measures and radii were revised. As regards nuclear installations that are being decommissioned, the special characteristics that are due to the changed hazard potential were adequately considered in the consultations.

The SSK's statement on the organisation of emergency care centres was published in 2014, in particular so that the standards concerning the operation of emergency care centres could be harmonised further.

Accidents and events classified higher than INES Level 0

During the reporting period (2014 to 2016), there were no accidents in German nuclear installations as defined under the national nuclear rules and regulations and no events classified INES Level 1 (deviation from the permissible ranges for the safe operation of the installation) or higher (→ Table 19-1).

However, report is given on an INES Level 1 event in 2013 to supplement the report for the Sixth Review Meeting.

"Vienna Declaration on Nuclear Safety" of 9 February 2015

The Federal Republic of Germany declares that the obligations under the "Vienna Declaration on Nuclear Safety" are fulfilled in Germany. This is addressed in more detail in Articles 6, 14, 17, 18 and 19.

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

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 – Overview

In Germany, there are a total of 18 nuclear installations as defined by the Convention (→ Figure 6-2). Of these 18 nuclear installations, eight nuclear installations at seven sites are in power operation, with a gross generating capacity of a total of 11,357 MWe (→ Appendix 1-1a). Nine nuclear installations are in the post-operational phase. In these, the fuel is still inside the installations, either in the RPV (Brunsbüttel), in the spent fuel pools or in storage casks (CASTOR) in the storage facilities at the respective sites. One installation is under decommissioning (Obrigheim nuclear power plant), but here is still spent fuel in the external spent fuel pool inside the emergency building (→ Figure 6-1).

Due to the nuclear accident at Fukushima on 11 March 2011, the AtG was amended (13th amendment) in Germany in the very same year. As a result, the power operation licences for the commercial generation of electricity of the Krümmel nuclear power plant (commissioned in 1984) and the seven oldest nuclear installations that had been commissioned up to and including 1980 were invalidated. These nuclear installations are currently in their post-operational phases. In 2011 it was further specified in the AtG that the licences for power operation of all remaining nine nuclear installations will successively become invalid by 31 December 2022 at the latest (§ 7 para. 1a, sentence 1 AtG).

During the course of the reporting period, the Grafenrheinfeld nuclear power plant would have lost its power operating licence on 31 December 2015 at the latest. However, based on the licence holder's decision, the Grafenrheinfeld nuclear power plant was already permanently taken out of operation on 27 June 2015.

The power reactors built in Germany for commercial electricity generation can be divided into four construction lines for PWR and two production lines for boiling water reactors (BWR), depending on the designs when they were built. The classification of the individual nuclear installations according to construction lines can be found in Appendices 1-1a and 1-1b. Appendix 4 contains a compilation of technical details on the nuclear installations of the different construction lines. It lists fundamental safety-relevant characteristics of the installations 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 hazards.

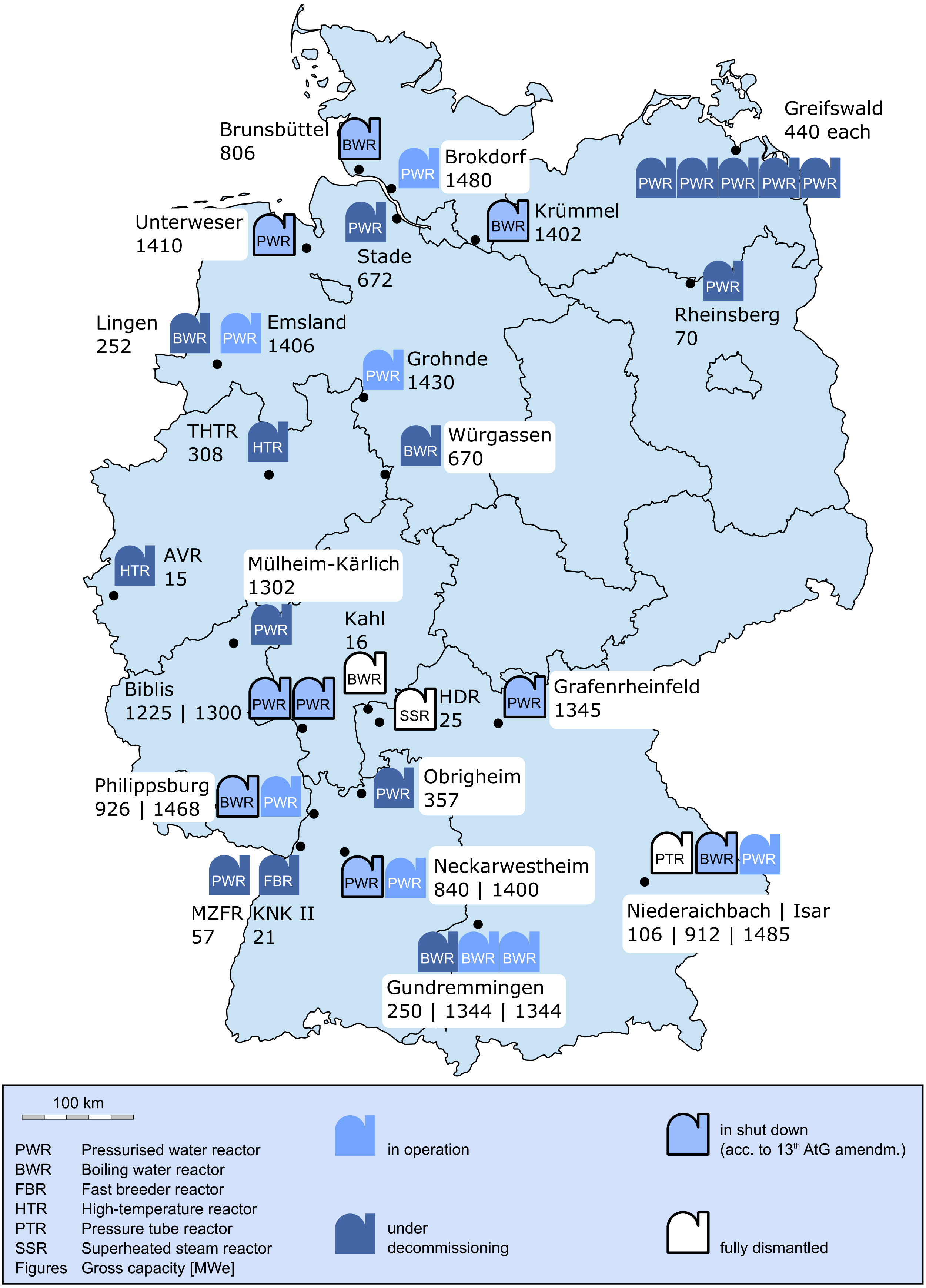

Figure 6-1 **Nuclear installations for electricity generation and experimental and demonstration reactors under decommissioning or already dismantled in Germany (→ Appendix 1-1a, 1-1b, 1-2, 1-3)**

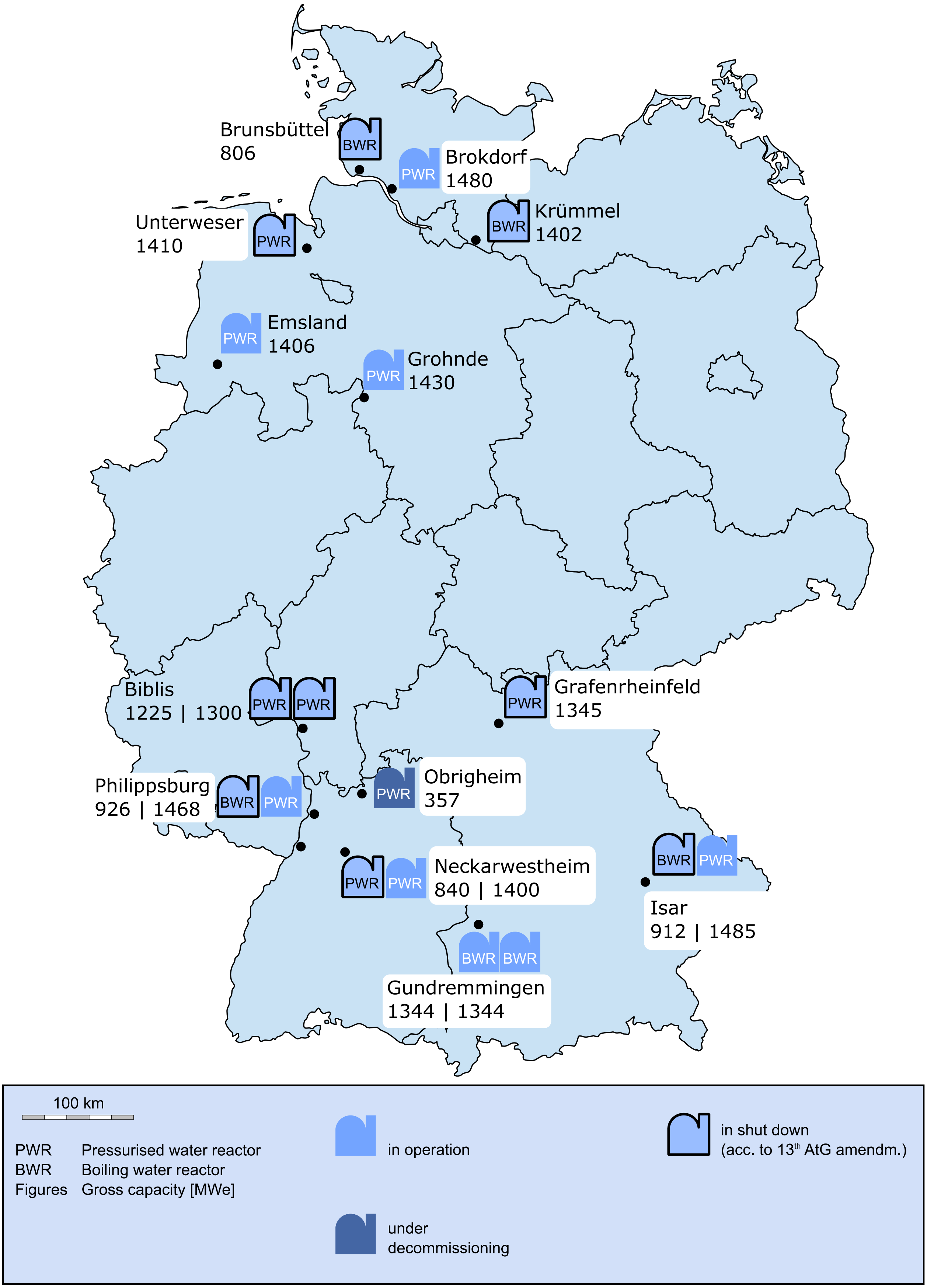

Figure 6-2 **Nuclear installations for electricity generation in Germany as defined by the Convention**

Operation of the nuclear installations as defined by the Convention

In 2015, gross electricity production in Germany was 647.1 TWh[18]. The contribution of nuclear power was 14.1 %.

In 2014, gross electricity production was 627.8 TWh. In that year, nuclear power contributed 15.5 %.

Table 6-1 shows the average availabilities of the German nuclear installations. Since the capacity factor is the product of capacity and availability factor, the average capacity factor of all German nuclear installations may be larger than the average availability factor.

Table 6-1 Average availabilities of German nuclear installations

Year	Time availability in %	Energy availability in %	Energy utilisation in %
2015	91.8	91.2	82.2
2014	90.6	89.1	86.8
2013	89.2	88.7	87.2
2012	91.0	90.5	88.9
2011	82.1	81.9	68.2
2010	76.4	77.5	74.0
2009	73.2	74.2	71.2
2008	80.0	80.9	78.4
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: possible energy generation/nominal energy
Energy utilisation: actual energy generation/nominal energy

Use of mixed-oxide fuel

The utilisation of plutonium from the reprocessing of irradiated fuel from German nuclear installations in other European countries (France and Britain) takes place through the use of MOX (mixed-oxide) fuel in nuclear installations.

In Germany, MOX fuel is used in the installations due to the utilisation obligation under § 9a para. 1 AtG. Since 1 July 2005, the transport of spent fuel for reprocessing has been banned. By 31 December 2015, 100% of the plutonium that had entered reprocessing prior to 1 July 2005 had been made part of MOX fuel and transported to the respective nuclear power plants. By 31 December 2015, around 99.3 % of the plutonium that had entered reprocessing prior to 1 July 2005 had been recycled. By the end of 2016, the remaining amount of MOX should have been used for electricity production in reactors and thus have been recycled.

The higher content of plutonium in MOX fuel leads to a harder neutron flux spectrum and to changes in the reactivity coefficients. As the use of MOX fuel is an “essential modification of the installation” according to the AtG, a corresponding licence, issued by the competent nuclear licensing and supervisory authority of the *Land* is required. To obtain this licence, it has to be shown that

18 BMWi, http://www.bmwi.de/DE/Themen/Energie/Energiedaten-und-analysen/Energiedaten/energietraeger.html, accessed on 21 March 2016

all transients and design basis accidents can be controlled with the modified core configuration. The competent licensing and supervisory authorities of the *Länder* have issued licences for the use of MOX fuel in the eight reactor units still in operation in 2016. The licensed deployable amounts of MOX fuel are specified individually for each installation and lie between 25% and 50% of the total number of fuel assemblies in the core.

Modification licences

In the years 2013 – 2015, a total of five modification licences were granted for the nuclear installations. They all concerned the organisational structure of the licence holders of the nuclear installations in the *Land* of Baden-Württemberg.

For the adaptation of the organisational structure of EnBW Kernkraft GmbH (EnKK) at the Neckarwestheim, Obrigheim and Philippsburg sites to the 13^{th} AtG amendment, five licences according to § 7 AtG were granted on 21 November 2014 for the nuclear power plant units Neckarwestheim 1, Neckarwestheim 2, Obrigheim, Philippsburg 1 and Philippsburg 2. Of these five nuclear installations, two are in power operation, (Philippsburg 2, Neckarwestheim 2), two are in their post-operational phase (Philippsburg 1, Neckarwestheim 1) and one is under decommissioning (Obrigheim).

Post-operational phase

The nine nuclear installations whose power operation licences have expired pursuant to the 13^{th} AtG amendment are currently in the post-operational phase. Except for the Brunsbüttel nuclear power plant, the fuel has been removed from the reactors of all these nuclear installations and placed in the spent fuel pools. By August 2015, the licence holders of these nine nuclear installations had filed applications for decommissioning and dismantling on the following dates:

- Unterweser and Isar 1 nuclear power plants: 4 May 2012
- Biblis nuclear power plant, units A and B: 6 August 2012
- Brunsbüttel nuclear power plant: 1 November 2012
- Neckarwestheim 1 and Philippsburg 1 nuclear power plants: 24 April 2013
- Grafenrheinfeld nuclear power plant: 28 March 2014 (shutdown 27 June 2015)
- Krümmel nuclear power plant: 24 August 2015

Research reactors

Research reactors do not represent 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, seven research reactors are operated, with a capacity between 100 mW and 20 MW thermal power (→ Appendix 2-1). The licence holders of these research reactors are public or state-sponsored universities and research centres. Three of these research reactors with a capacity between 100 kW and 20 MW thermal power are primarily operated as neutrons sources for research. The remaining four research reactors (training reactors) with capacities of 100 mW and 2 W thermal power, respectively, are operated for the purpose of practical training in the fields of reactor physics and radiation protection at the universities at Furtwangen, Stuttgart, Ulm and Dresden.

Four research reactors have been permanently shut down (→ Appendix 2-1b); six research reactors are in the decommissioning phase and are being dismantled (→ Appendix 2-2). Figure 6-3 shows the sites of research reactors (in December 2015).

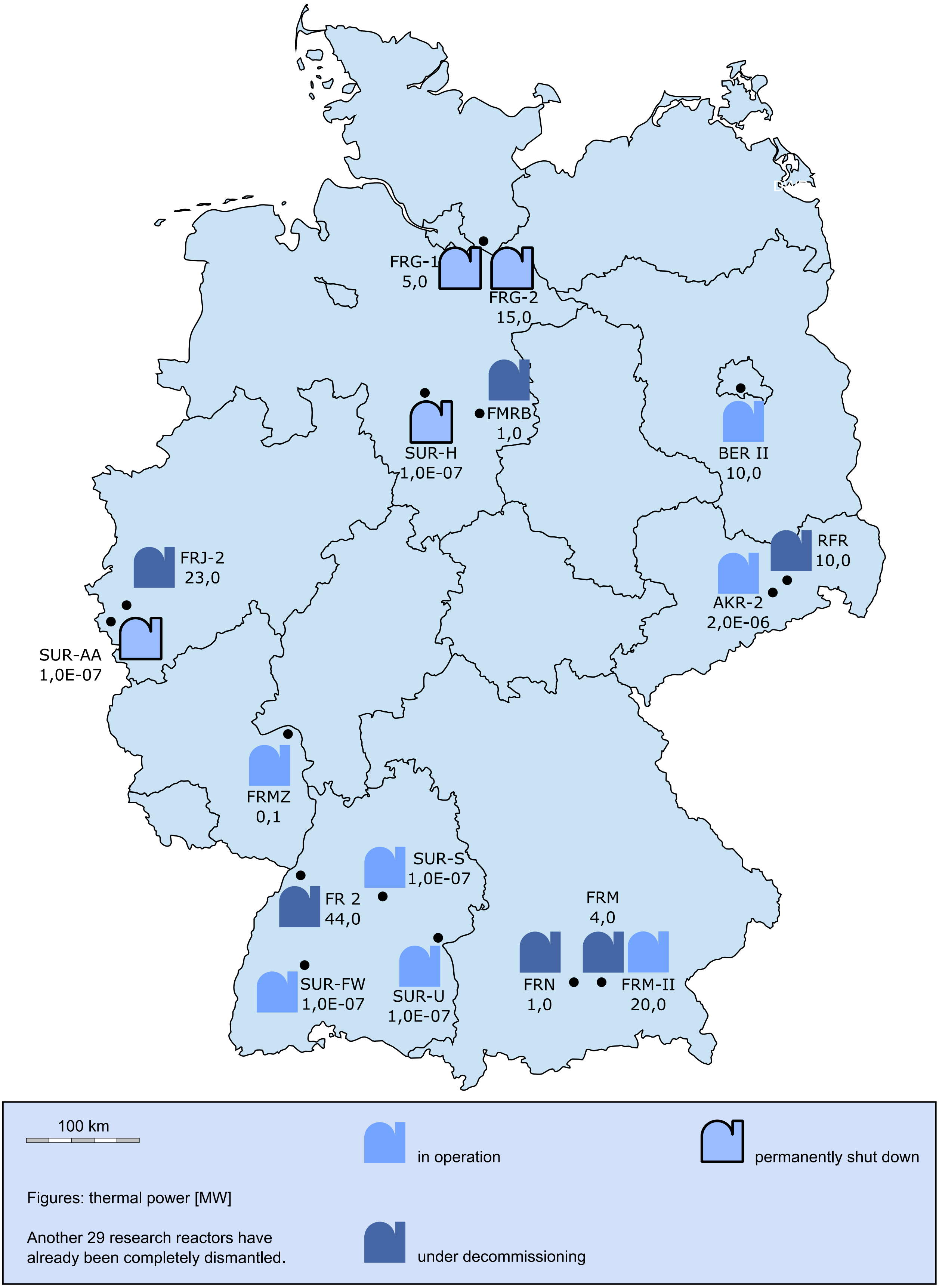

Figure 6-3 Research reactors in Germany

For the licensing and supervision of research reactors, the nuclear safety regulations for power reactors are applied among others. 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*.

In accordance with the Nuclear Safety Officer and Reporting Ordinance (AtSMV) (→ Article 19 (vi)), research reactors with a capacity of more than 50 kW thermal power are, like power reactors, subject to the obligations to notify in case of reportable events. When the AtSMV was amended in the year 2010, dedicated reporting criteria for research reactors were listed in Annex 3 of the AtSMV.

Other nuclear installations

To complete the picture of the utilisation of nuclear energy in Germany, a short survey of the other nuclear installations that are 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" (Joint Convention), about which report was last made by Germany within the framework of the Fifth Review Meeting in May 2015.

In 2015, altogether, 17 nuclear installations were under decommissioning; two of them, the Lingen nuclear power plant (KWL) and the Thorium High-Temperature Reactor (THTR), are in "safe enclosure" (→ Appendix 1-2). At the end of 2015, the KWL was granted a licence for the partial dismantling of individual plant components. The nuclear installations of the Großwelzheim superheated-steam reactor (HDR), the Niederaichbach nuclear power plant (KKN) and the Kahl experimental nuclear power plant (VAK) have already been fully dismantled and therefore been released from the scope of the AtG (→ Appendix 1-3).

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). These are the uranium enrichment plant at Gronau and the fuel assembly fabrication plant at Lingen. The Karlsruhe reprocessing plant (WAK) ended operations for good in 1991 and has been in the process of dismantling since 1993. Several fuel fabrication plants have completely been dismantled.

In the Federal Republic of Germany, spent fuel from the operation of power and research reactors is stored in central storage facilities (Ahaus transport cask storage facility (TBL), TBL Gorleben and the Nord storage facility in the vicinity of Greifswald), in decentralised storage facilities (cask storage facility of the "Arbeitsgemeinschaft Versuchsreaktor (AVR) Jülich") and in storage facilities at the sites of the nuclear installations. The obligation of the nuclear installation licence holders to put the irradiated fuel from the operation of the respective nuclear installations into on-site storages at the sites of the nuclear installations to avoid transports was laid down in the AtG in the year 2002. Sending spent fuel from nuclear installations for the commercial generation of electricity to a reprocessing plant abroad and hence shipping spent fuel to France or Great Britain was only an option until 30 June 2005.

From 1971 to 1991 and 1994 to 1998, low-level and medium-level waste was disposed of in the Morsleben repository (ERAM). ERAM is the first repository in deep geological formations that is decommissioned according to the licensing procedure under nuclear law with the involvement of the general public. At present, the licensing procedure under nuclear law is ongoing, following the provisions of the Nuclear Licensing Procedure Ordinance (AtVfV) [1A-10].

From 1969 until 1978, low-level and medium-level waste was emplaced in the Asse II mine. On 1 January 2009, the Federal Office for Radiation Protection (BfS) assumed responsibility for the operation of the Asse II mine under atomic and mining law. The BfS was given the task to decommissioning the Asse II mine safely under atomic law. According to an amendment of § 57b AtG with the "*Asse Act*"[19] of 24 April 2013, decommissioning is to start following the retrieval of the radioactive waste.

The plan approval procedure for the Konrad repository was ended with the plan approval decision which became final in April 2007. Refitting of the existing former Konrad iron ore mine started in May 2007. It is planned to take the mine into operation as a repository for low- and medium-level waste after completion of the refitting work, presumably in the year 2022.

The site for a repository especially for high-level radioactive waste is to be legally defined by the year 2031 in a site selection procedure. For this purpose, the Site Selection Act (StandAG) was promulgated on 23 July 2013 [1A-25]. Until the summer of 2016, the "Commission on the storage of highly radioactive materials" is to evaluate in particular the site selection procedure and develop criteria for the search for and selection of a repository site.

The exploration work in the Gorleben mine was interrupted in 2000 for a period of 10 years. Following its resumption in October 2010, exploration was again suspended in November 2012. With the entry into force of § 29 StandAG, the mining-related exploration of the Gorleben salt dome was ended on 27 July 2013. In June 2015, the BfS submitted a comprehensive concept to the mining authority of the *Land* solely for keeping the mine open. The work for guiding the mine towards an operating condition intended solely to keep it open was executed in accordance with the main plan of operations for the Gorleben mine.

Overview of important safety issues including selected events

Over the past years, an increase in the number of events involving lasting deformations of fuel assemblies has been observed in German nuclear installations with PWR. All these events were classified as INES level 0. The deformations led to handling problems and in individual cases also to longer drop times or to the failure to reach the lower end position upon control element dropping. The different nuclear installations were affected to varying degrees by this circumstance. The fuel assembly deformations resulted from external loads acting on the fuel assemblies and depended on their load-shedding behaviour. In 2015, the RSK issued a statement on this phenomenon[20]. The licence holders and manufacturers carried out different measures to reduce fuel assembly deformation, especially aimed at reducing the hold-down forces, increasing the creep limit and lateral fuel assembly stiffness, and restricting the effects of deformed fuel assemblies. The RSK believes that these measures have led to a relative improvement of the situation and promise further improvement.

In the following, other reportable events are presented that occurred after the deadline for the 6th CNS National Report:

In 2012 and 2013, cases became known from one installation, involving broken or cracked fuel assembly centering pins in the grid plate of the upper core structure as well as one broken-off fuel assembly centering pin in the fuel assembly top plate of the lower core structure. In the grid plate of the upper core structure and in the fuel assembly top plate of the lower core structure there are two fuel assembly centering pins for each fuel assembly; their function is to maintain the fuel assemblies in a central position upon placing them into the lower and upper core structure, to keep them in position during operation, and to shed lateral forces together with the core baffle. To do so, the fuel assembly centering pins engage in the corresponding boreholes in the fuel assembly top and bottom end pieces. The fuel assembly centering pins affected were made of the nickel alloy Inconel X-750 or of the austenitic material 1.4571. In both cases, typical characteristics of intergranular stress corrosion cracking were found on the crack surfaces. Individual breaks of fuel as-

19 "Gesetz zur Beschleunigung der Rückholung radioaktiver Abfälle und der Stilllegung der Schachtanlage Asse II", Federal Law Gazette, 24 April 2013

20 RSK statement, "Deformations of fuel assemblies in German pressurised water reactors (PWRs)", adopted at the 474th RSK meeting on 18 March 2015 (in German)

sembly centering pins in the upper and lower core structure have no influence on the capability of shutting down and cooling the core safely. Cracked and bent fuel assembly centering pins may lead to fuel damage upon the insertion of the grid plate. All faulty fuel assembly centering pins were exchanged for new ones made of the cold-worked austenitic steel 1.4571. This measure was partly or in some cases fully carried out during the reporting period.

A reportable event occurred on 30 May 2015 upon the shutdown of a nuclear installation for its overall maintenance and refuelling outage in connection with the in-service inspection of the functioning of a main-steam relief isolation valve. The isolation valve had to be opened for an inspection. In the course, there was an unexpected release of main-steam from a drain pipe of the main-steam relief line. The relief isolation valve was closed again manually and the release of main-steam was thereby stopped. The cause of the failure was found to be an approx. 30-cm-long crack in the drain pipe due to wall thickness degradation. Inspections of the corresponding drain pipes of the redundant main-steam relief lines also revealed degradations of the wall thickness. Some of these degradations were below the required minimum wall thickness levels. The drain pipes affected are isolated in normal operation. The cause was found to be condensed water in the pipe sections affected that had led to corrosion and thus to wall thickness degradation. The faulty sections of the pipes were exchanged and the drain pipes affected were included in the in-service inspection programme.

During the review period (2014-2016), there were no events of INES level 1 or higher.

Between the deadline for the report for the Sixth Review Meeting and the start of the review period for the Seventh Review Meeting, the reportable event “not effected unlocking of a valve in the residual-heat removal system” occurred on 6 October 2013, which was classified as INES level 1 and reported to the IAEA. In this event, a residual-heat removal train in a nuclear power plant that had been shut down for overall maintenance and refuelling was to be started up for an inspection. In the course it was found that a check valve was still locked in CLOSED position. This locking should already have been undone when the outage-related isolation of the emergency core cooling and residual-heat removal train affected was ended; it also went unnoticed during several subsequent working steps and checks. Due to the fact that the valve was locked in its position, the residual-heat removal train affected was no longer available for certain emergency conditions. The other residual-heat removal train had been isolated for maintenance, which is why for a short period of time, the safety function of “residual-heat removal” was not available and the event was therefore classified in the reporting category “E” (urgent report) in accordance with the AtSMV. The cause can be put down to deficiencies in “work execution” and “non-observance of rules”, which was also the reason for the classification as INES level 1. To prevent similar events from happening in the future, organisational measures were taken at this power plant.

Safety-related recommendations of the RSK and the SSK on national and international events during the review period

Against the background of several events in foreign installations, the RSK looked into the issue of *faults in one or two phases of the main, standby or emergency grid connection*[21] in 2014. Such an “open-phase condition” has so far not been adequately considered in the design of nuclear installations worldwide. It may, however potentially affect all safety systems at the same time. Hence the RSK made eight fundamental recommendations for the identification and control of asymmetrical conditions regarding electricity or voltage. Furthermore, two interim measures for protection against the simultaneous failure of safety equipment due to asymmetrical conditions in the electrical power supply were recommended. Safety-related requirements for the safe detection of open phase conditions were already adopted into the “Safety Requirements for Nuclear Power Plants” and their “Interpretations” in 2013.

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21 RSK recommendation “Ein-oder zweiphasiger Ausfall des Haupt-, Reserve- oder Notstromnetzanschlusses”, adopted at the 467th RSK meeting on 26 June 2014

In the *basic recommendations for the planning of emergency control measures by the operators of nuclear power plants*[22], general requirements for on-site emergency planning by the licence holders of nuclear installations are formulated. The version that had last been revised in 2010 was supplemented by the RSK and the SSK in 2014. The added aspects take the lessons learned from the Fukushima nuclear accident and the current state of the art in science and technology into account and supplement the corresponding RSK and SSK recommendations of the past years as well as plans for on-site emergency preparedness measures implemented by the German nuclear installations.

As a result of discussions about the applied methodology in connection with Man-Technology-Organisation event analyses, the RSK prepared the *guideline for the performance of integrated event analyses*[23] in 2014. The aim of such an integrated event analysis is to identify if possible all contributing factors from the areas man, technology and organisation as well as their interactions in order to be able to derive suitable actions that are to prevent a repeat or the occurrence of similar events. Besides fundamental provisions regarding the scope and depth of the analysis methods, the requirements listed in the guideline also comprise organisational requirements for the licence holders of the nuclear installations.

In connection with the hydrogen explosions in three reactor units at Fukushima, the RSK dealt with the topic of *hydrogen release from the containment*[24] in 2015 by request of the BMUB. This was done against the background of considerations that hydrogen might possibly be released from the containment via leaks into areas outside the containment that are not monitored for hydrogen and/or in which no measures to cope with hydrogen exist. The discussions among the RSK resulted in three recommendations which demand that it has to be shown that hydrogen deflagrations will not have any safety-relevant consequences.

To back up the demonstration criteria for a loss-of-coolant accident in a PWR, the RSK dealt with the *demonstration of residual ductility/residual strength using an ECR criterion*[25] in 2015. This was caused by findings from experiments that suggested that the residual ductility/residual strength of fuel cladding tubes depends not only on oxidation but also on the hydrogen concentration in the cladding. Hence, due to operational as well as accidental hydrogen uptake, it might not be possible to safely exclude that in areas of burst cladding, the cladding might rupture upon thermal shock impact. The RSK therefore issued recommendations regarding the verification procedure to prevent fragmentation of the fuel cladding in a loss-of-coolant accident.

By request of the BMUB and in reaction to the discussions that arose during the adaptation of the to-be-revised KTA Safety Standards to the general “Safety Requirements for Nuclear Power Plants”, the RSK prepared recommendations on the *requirements for spent fuel pool cooling*[26] in 2015. Within the framework of the discussions, the RSK found that there was room for interpretation in the “Safety Requirements for Nuclear Power Plants” regarding spent fuel pool cooling. Based on investigations of existing system configurations and designs, seven recommendations were made to prevent impermissible plant states.

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22 SSK and RSK recommendation, “Rahmenempfehlungen für die Planung von Notfallschutzmaßnahmen durch Betreiber von Kernkraftwerken”, adopted at the 242nd SSK meeting on 1/2 June 2010, adopted at the 429th RSK meeting on 14 October 2010, supplement adopted at the 468th RSK meeting on 4 September 2014 and the 271st SSK meeting on 21 October 2014

23 RSK recommendation “Leitfaden für die Durchführung von ganzheitlichen Ereignisanalysen”, adopted at the 470th RSK meeting on 6 November 2014

24 RSK recommendation, “Wasserstofffreisetzung aus dem Sicherheitsbehälter”, adopted at the 475th RSK meeting on 15 April 2015

25 RSK recommendation “Nachweis einer Restduktilität/Restfestigkeit mittels einer ECR-Grenzkurve”, adopted at the 476th RSK meeting on 24 June 2015

26 RSK recommendation “Anforderungen an die Brennelement-Lagerbeckenkühlung”, adopted at the 479th RSK meeting on 9 December 2015

Overview of planned programmes and measures for continuous improvement of safety

The safety of the nuclear installations is continuously reviewed in an on-going process within the framework of regulatory supervision. If there are any new safety-related findings, their applicability to other nuclear installations and the need for any possible backfitting measures is examined (→ Article 8).

Most noteworthy in this context are the recommendations and suggestions derived after the nuclear accident at Fukushima regarding possible measures subsequent to the “RSK-SÜ”, the “EU stress tests” and the information notice “WLN 2012/02”. Due to these recommendations and supplementing measures taken by the licence holders, diverse supplementary preventive emergency measures were implemented in all nuclear installations that are in power operation. These measures are described in the National Action Plan. Some of these measures are described below.

Measures were taken to further improve the electrical energy supply. To re-establish the AC power supply in an emergency, mobile diesel generators were provided at the nuclear installations and suitable external connections for these generating units were installed in order to be able to provide an additional emergency power supply. Moreover, within the first ten hours, DC power supply via diesel generator units and batteries has to be ensured in the beyond-design area. These measures were implemented in all nuclear installations that are still in power operation.

Regarding residual-heat removal from the reactor core and the spent fuel pool, the emergency measures were supplemented or optimised. For this purpose, mobile pipe and hose connections were provided in some nuclear installations to build up corresponding mobile residual-heat removal chains. Cooling water sources independent of the ultimate heat sink were exploited or installed wherever these were yet not available.

Beside these measures, the licence holders also implemented recommendations by the RSK on emergency preparedness, seismic design, and the determination of the robustness of the nuclear installations. Moreover, a concept was developed for coping with severe accidents in the form of the HMN as a supplement to the existing emergency manuals (NHB). The strategies and procedures contained in these manuals correspond to the international recommendations on “Severe Accident Management Guidelines” (SAMG). This concept has in the meantime been introduced at all nuclear installations that are in power operation.

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

For the Federal Government, the safe operation of the nuclear installations in Germany and also in the neighbouring countries has top priority. Research projects for assessing the safety of the operation of nuclear installations are continued. It is to be ensured by research projects that the capability to judge the safety of nuclear installations in neighbouring countries on the basis of own expertise is maintained even after the cessation of power operation of the nuclear installations in Germany.

International developments are monitored, and the question is examined to what extent the objectives with regard to further increased reactor safety, proliferation resistance (in the case of research reactors) and reduction of radioactive waste and its safe storage can possibly be used to the advantage of Germany.

Through the funding priority “reactor safety research” of the Federal Ministry of Economics and Technology (BMWi), the Federal Republic of Germany participates in the international advancement of the safety of nuclear installations by performing its own, independent research. This includes participation in international research and development projects. Especially, Germany participates in safety-oriented experimental research projects under the auspices of OECD/NEA. As a flanking measure, the Federal Ministry for Research and Education funds projects on the topic of reactor safety as part of the sponsorship initiative “Fundamental R&D in nuclear safety and waste management research to promote junior scientists and to maintain competence”.

The research work sponsored by the BMWi deal amongst other things with experimental or analytical studies on

- plant behaviour of nuclear installations under accident conditions,
- non-destructive early detection of damage for materials difficult to inspect,
- safety of pressurised components,
- core meltdown,
- safety of digital instrumentation and control,
- human factors and safety culture as well as
- development of probabilistic safety analysis methods.

New research projects also included in particular projects initiated in the wake of the Fukushima accident.

Computer codes developed as part of BMWi-sponsored projects are available to the supervisory authorities and their authorised experts for analyses of the safety of nuclear installations.

The licence holders (VGB) of nuclear installations, too, give high priority to research and development in the field of nuclear safety. Due to the decision taken to phase out the use of nuclear power for the commercial generation of electricity by the year 2022, the licence holders focus their efforts on the operation of the remaining operating installations as well as on decommissioning and dismantling. Currently, about 80 projects are underway, and about 50 new projects with a total volume of orders of several million euros start each year (as at: January 2016). Focal points are, amongst others:

- materials science
- component and system engineering
- accident analysis
- non-destructive testing
- probabilistic safety analysis
- fuel behaviour
- radiation protection
- seismic safety.

Activities of the BMUB

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

The BMUB keeps continuously up to date with the developments in the area of nuclear safety by taking an active part in the work of international committees and working groups (IAEA, OECD/NEA, committees resulting from bi- and multilateral agreements and treaties, etc.). The results of the work of these committees and working groups as well as of the research programmes and research and development projects sponsored by the Federal Government at international level influence the constant improvement of the requirements for the safety of the nuclear installations in accordance with the state of the art in science and technology. The BMUB also requests its advisory commissions RSK, ESK and SSK (→ Article 8) to comment on selected developments and events in the area of nuclear safety and to make recommendations. The expert organisation GRS supports the BMUB and carries out its own research on the safety of nuclear installations from a generic point of view by request of the BMUB. GRS evaluates events that have occurred in German and also in foreign nuclear installations with regard to their safety significance and applicability to other installations and prepares recommendations in the form of WLNs.

Position of the Federal Republic of Germany on the safety of the nuclear installations in Germany

With the enactment of the 13th amendment of the AtG, the decision taken by the Federal Government to terminate the use of nuclear power for the commercial generation of electricity in the Federal Republic of Germany by the year 2022 was implemented. Regardless of the decision to phase out nuclear power, the Federal Government commits expressly to continue maintaining or enhancing the high level of nuclear safety of the German nuclear installations. Major elements in ensuring safety are the licence holder's responsibility for the safety of the nuclear installations and the comprehensive supervision by the competent nuclear licensing and supervisory authorities.

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

Progress and changes since the year 2014

Besides the permanent nuclear supervision of the nuclear installations, § 19a AtG demands a ten-yearly safety review of the nuclear installations in power operation. This has been carried out for all nuclear installations in power operation. At the time of writing of this report, safety reviews from the period 2006-2010 are available, depending on the installation (→ Article 14). Owing to the shutdown of further nuclear installations in line with the 13th amendment of the AtG in the year 2011 and due to the fact that the AtG only demands safety reviews to be carried out until up to three years before shutdown, safety reviews are in future only expected for two nuclear installations (Gundremmingen C and Brokdorf). As for the nuclear installations in post-shutdown operation, the General Committee of the LAA has decided that the licence holder has to prepare a “Safety Analysis for the post-operational phase”. Details on how this should be done were specified in a “Check list for the performance of an assessment of the current safety status of the installation for the post-operational phase” [3-22] in the year 2014.

Implementation of the “Vienna Declaration on Nuclear Safety”

In the “Vienna Declaration on Nuclear Safety” of February 2015, additional provisions were specified in order to achieve the aims of the Convention – the prevention of accidents with radiological consequences and, if possible, the mitigation of the possible effects of accidents. In the following, the implementation of these provisions in Germany is outlined.

According to § 7 para. 1 AtG, no licences are granted “…to erect and operate an installation for the fission of nuclear fuel for the commercial generation of electricity…”. Hence, no rules for new nuclear installations in terms of Item 1 of the “Vienna Declaration on Nuclear Safety” are necessary any more for the national nuclear regulations. For the nuclear installations in power operation, the national nuclear regulations demand that events that may lead to a general failure of the installations and equipment serving for defence in depth and therefore to early or large releases will, using the measures and equipment of accident management, be practically excluded[27] or that the radiological consequences will be limited to such an extent that off-site emergency measures will only become necessary to an extent that is limited both in space and in time (see “Safety Requirements for Nuclear Power Plants”). This can be demonstrated by way of the fulfilment of the requirements

[27] The occurrence of an event or event sequence or a state can be considered as excluded if it is physically impossible to occur or if it can be considered with a high degree of confidence to be extremely unlikely to arise [3-0.1].

for operational management, for the high reliability of safety systems, and for comprehensive accident management (→ Article 18).

Since 2002, § 19a para. 1 AtG has been demanding a ten-yearly safety review of nuclear installations in power operation (→ Article 14). For nuclear installations in transition from power operation to post-operation, a safety status analyses be prepared on the basis of the "Check list for the performance of an assessment of the current safety status of the installation for the post-operational phase" was made mandatory. Since 2010, this has also additionally been required by § 19a para. 3 AtG for other nuclear installations in accordance with Directive 2009/71/EURATOM [1F-1.25]. This safety review represents a supplement to the continual review within the framework of nuclear supervision in Germany. The results are presented by the licence holders to the respective competent nuclear licensing and supervisory authorities of the *Land* (→ Article 8); they are then assessed by independent authorised expert organisations tasked to do so by the *Land*. A final assessment is made by the competent nuclear authority.

Accident management measures, especially in the preventive range, were already recommended by the RSK after the Chernobyl accident and implemented by the licence holders. In addition to that, in reaction to the Fukushima nuclear accident, an HMN was implemented additional to the NHB at all nuclear installations in power operation (→ Article 14). The measures implemented in German PWRs until 2011 are shown in Table 6-2. Table 6-3 shows this information analogously for German BWRs. The measures taken during and after 2011 are presented in the National Action Plan (→ Appendix 6).

The national nuclear regulations in Germany have been constantly developed and adapted to the progressing state of the art in science and technology since the 1970s. This grown structure does not readily permit the verbatim implementation of new requirements from IAEA safety standards. The current state of the art in science and technology is based i.a. on the IAEA safety standards; hence, these are considered by analogy in the revision of the national nuclear regulations.

Future activities

The safety assessments are within the framework of nuclear licensing and supervision will be continued, as will be the additional mandatory safety reviews. The recommendations set out in the National Action Plan and its updated version Update of the German Action Plan provide the basis for the actual plant specific measures in the nuclear installations specified so far (→ Appendix 6). The implementation of these measures and a plant specific review of the recommendations will be performed within the framework of the nuclear supervisory procedure.

Pursuant to the AtG, the installations in power operation listed below are scheduled to be shut down at the following dates at the latest:

- Gundremmingen B 31 December 2017
- Philippsburg 2 31 December 2019
- Grohnde 31 December 2021
- Gundremmingen C 31 December 2021
- Brokdorf 31 December 2021
- Isar 2 31 December 2022
- Emsland 31 December 2022
- Neckarwestheim II 31 December 2022

Table 6-2 Accident management measures implemented in German PWRs until 2011

Measure	Construction line 2				Construction line 3				Construction line 4		
	KWB A	GKN I	KWB B	KKU	KKG	KWG	KKP 2	KBR	KKI 2	KKE	GKN II
Emergency manual	●	●	●	●	●	●	●	●	●	●	●
Secondary-side bleed	●	●	●	●	●	●	●	●	●	■	■
Secondary-side feed	●	●	●	●	●	●	●	●	●	●	●
Primary-side bleed	●	●	●	●	●	●	●	●	●	●	●
Primary-side feed	●	●	●	●	●	●	■	●	●	■	■
Containment isolation	●	●	●	●	●	■	●	●	●	■	■
Filtered containment venting	●	●	●	●	●	●	●	●	●	●	●
Passive autocatalytic recombiners	●	●	●	●	●	●	●	●	●	●	●
Filtering of control room air	●	●	●	●	●	●	●	●	●	■	●
Emergency power supply by neighbouring unit	●	●	●	□	□	□	●	□	□	□	●
Sufficient battery capacity	●	●	●	■	●	■	●	●	●	●	●
Re-establishment of the external electrical energy supply	●	●	●	●	●	●	●	●	●	●	■
3rd grid connection (underground cable)	●	●	●	●	●	●	●	●	●	●	●
Containment sampling system	○	●	●	●	●	●	●	●	●	●	●

● Realised through backfitting ■ Design ○ Applied for □ Not applicable

Table 6-3 Accident management measures implemented in German BWRs until 2011

Measure	SWR 69				SWR 72	
	KKB	KKI 1	KKP 1	KKK	KRB II B	KRB II C
Emergency manual	●	●	●	●	●	●
Diverse emergency HPCI system (steam-driven pump)	●	●	●	●	●	◻
Additional RPV injection and makeup system	●	●	●	●	●	●
Containment isolation	●	●	●	●	■	■
Diverse RPV pressure limitation	●	●	●	●	●	●
Filtered venting	●	●	●	●	●	●
Inerting of containment with nitrogen	●	●	●	●	●*	●*
Filtering of control room air	●	●	●	●	●	●
Emergency power supply by neighbouring unit	◻	◻	●	◻	●	●
Increase of battery capacity	●	■	●	●	■	■
Re-establishment of the external electrical energy supply	●	●	●	●	●	●
3rd grid connection (underground cable)	●	●	●	●	●	●
Containment sampling system	**	●	●	●	○	●

● Realised through backfitting ■ Design ○ Applied for ◻ Not applicable

* Pressure suppression pool inerted, drywell and pressure suppression pool with passive autocatalytic recombiners (PAR)

** Proposal in process

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 Federal 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 (→ Article 8). The Basic Law (GG) [1A-1] lays down provisions on the legislative and administrative competencies of the Federation and the *Länder* regarding the use of nuclear energy (Article 73 para. 1, no. 14, 85, 87c GG). Accordingly, this field falls within the exclusive legislative competence of the Federation, which also includes the further development of nuclear law. The *Länder* are involved in the procedure.

According to § 24 para. 1 AtG in conjunction with Article 85 and 87c GG, the AtG and the ordinances based thereon are executed – with some exceptions – by the *Länder* on behalf of the Federation (federal executive administration). Here, the Federation exercises supervision of legality and expediency and may, in the individual case, issue binding directives to the nuclear licensing and supervisory authority of a *Land*. 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 *Länder* remain responsible for administrative action with external effect; this competence to execute duties remains with the nuclear licensing and supervisory authority of the individual *Land*.

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 licence holders and also by third parties of the public concerned (guarantee of recourse to the courts according to Article 19 para. 4 GG). An action is brought against that authority which issued the notice/administrative act. In the area of nuclear law, this is the competent nuclear licensing and supervisory authority of the individual *Land*. This also applies in cases where the nuclear licensing and supervisory authority of a *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 licence holders may claim for granting of licences applied for or the residents for issuance of a regulatory order to cease operation of a nuclear installation.

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.

Incorporation of international and European law

International treaties

In the hierarchy of rules and legislation, the international treaties concluded by the Federal Republic of Germany in accordance with Article 59 para. 2, sentence 1 GG 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.

The most important international treaties of the Federal Republic of Germany in the fields of nuclear safety, radiation protection and liability as well as on national implementing provisions are to be found in Appendix 5. For the Federal Republic of Germany, the Convention on Nuclear Safety entered into force on 20 April 1997.

EU law

In Germany, legislation and administrative work must take into account any binding requirement from regulations of the EU. An overview of EU law, in particular in the field of radiation protection, is to be found in Appendix 5.

According to Article 77 of the Euratom Treaty, any utilisation of ores, source materials and special fissile materials is subject to surveillance by the European Atomic Energy Community (EAEC).

Council Directive 96/29/EURATOM [1F-2.1] of 1996, laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation, was transposed into national law by the Radiation Protection Ordinance (StrlSchV) [1A-8]. In 2013, the European radiation protection law, consisting of five directives, was fundamentally revised with Directive 2013/59/EURATOM [1F-2.1] and merged into a single directive. The deadline for transposition into national law ends on 6 February 2018.

On 22 July 2009, Council Directive 2009/71/EURATOM establishing a Community framework for the nuclear safety of nuclear installations entered into force to supplement the EURATOM directives on radiation protection. Thus, for the first time, legally binding European regulations had been established in the field of nuclear safety. The objective of the Directive is to maintain and continuously improve nuclear safety. The EU 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 installations, research reactors and storage facilities but not to disposal facilities 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 licensing and supervisory authorities, the obligations of the licence holders 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 among others by 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). Directive 2009/71/EURATOM has been transposed into national law with the *12th AtG amendment*[28].

With Directive 2014/87/EURATOM of 8 July 2014 [1F-1.25], Directive 2009/71/EURATOM has been amended. By this amendment, for the first time, general technical requirements for nuclear safety in Europe are laid down at a legally binding level, in particular the implementation of the defence-in-depth concept and clear allocation of responsibilities for on-site emergency response. Fur-

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28 12th Act amending the Atomic Energy Act, Federal Law Gazette, 8 December 2010

thermore, the member states are obliged to conduct - in addition to the self-assessment of the national legislative, regulatory and organisational framework and the competent nuclear licensing and supervisory authorities (so-called “peer review”) already contained in Directive 2009/71/EURATOM - topical peer reviews on a safety issue jointly to be selected by the member states at least every six years, starting in 2017. This is to initiate a continuous system of mutual learning from each other. The corresponding adaptation of the AtG is currently being prepared.

Council Directive 2011/70/EURATOM [1F-3.19] of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste was also to be transposed into national law in the member states. On 27 May 2015, the Federal Cabinet adopted the 14th amendment to the AtG. The amended AtG lays down the requirement to draw up a national programme for Germany (NaPro) that presents the national strategy for a responsible and safe management of spent fuel and radioactive waste in a legally binding manner. The Federal Cabinet adopted the NaPro on 12 August 2015. The NaPro itself has not the quality of a legal norm, but is to be considered in all radioactive waste management planning and administrative procedures by the actors in the field of nuclear waste. The accordingly amended AtG entered into force on 20 November 2015 with the 14th amendment to the AtG

7 (2i) Nuclear legal and regulatory framework

National nuclear legal and regulatory framework

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

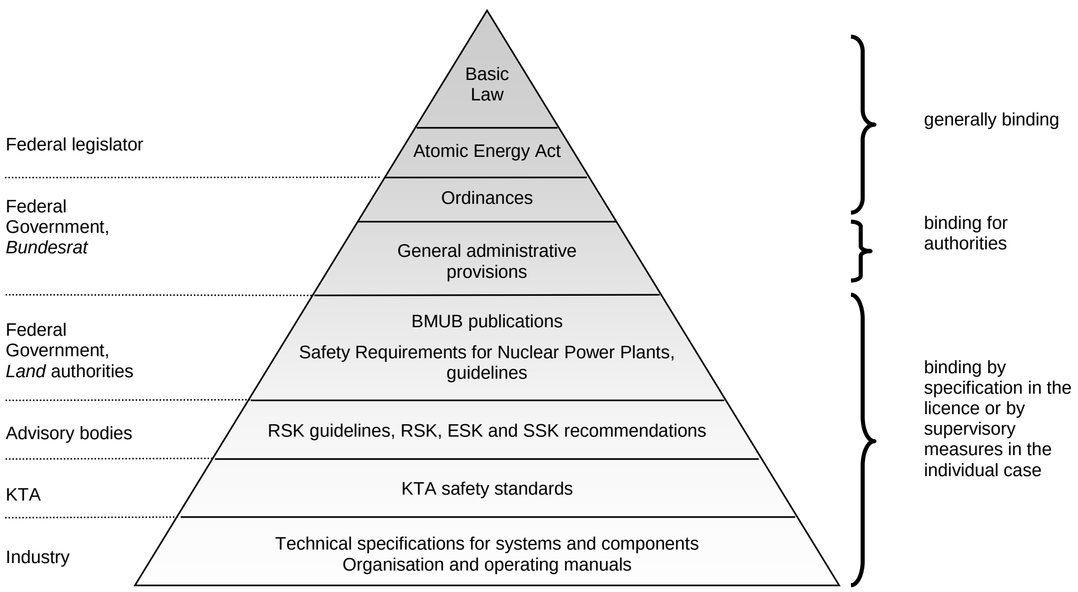

Figure 7-1 National regulatory pyramid

Acts, ordinances and administrative provisions

Basic Law (GG)

The GG lays down fundamental principles which also apply to nuclear law. Furthermore, the GG lays down provisions on the legislative and administrative competencies of the Federation and the *Länder* regarding the use of nuclear energy. According to Article 73 GG, the Federation shall have exclusive legislative power with respect to “the production and utilisation of nuclear energy for peaceful purposes, the construction and operation of facilities serving such purposes, protection against hazards arising from the release of nuclear energy or from ionising radiation, and the disposal of radioactive substances”. The *Länder* execute the Atomic Energy Act on behalf of the Federation (federal executive administration). Federal supervision shall extend to the legality and expediency of execution by the authorities of the *Länder*. According to Article 85 para. 3 GG, they shall be subject to instructions from the competent highest federal authority (BMUB).

The basic rights stipulated in the GG, in particular the basic right to life and physical integrity, determine the standard to be applied regarding the protective and preventive measures at nuclear installations, which is further specified in the hierarchical levels of the regulatory pyramid (→ Figure 7-1).

Formal federal law, in particular the AtG

The AtG was promulgated on 23 December 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 AtG after the amendment in 2002 is to phase out the use of nuclear energy for the commercial generation of electricity in a controlled and structured manner. Until that time, it is required to ensure orderly operation of the nuclear installations as well as to protect life, health and real assets against the hazards of nuclear energy and the harmful effects of ionising radiation and to provide compensation for any damage caused. It also has the purpose to prevent danger to the internal or external security of the Federal Republic of Germany from the use of nuclear energy. Another purpose is to ensure that the Federal Republic of Germany meets its international obligations in the field of nuclear energy and radiation protection.

On 30 June 2011, the *Bundestag* (German Federal Parliament) passed the 13th AtG amendment which includes new regulations on phasing out the use of nuclear energy for the commercial generation of electricity. The amended AtG entered into force on 6 August 2011. The amendments in the AtG stipulate the end of electricity generation by nuclear installations on a step-by-step basis by 31 December 2022 at the latest.

The AtG includes the general national regulations for protective and preventive measures, radiation protection as well as for radioactive waste and spent fuel management in Germany and is the basis for the associated ordinances.

Further to purpose and general provisions, the AtG also comprises surveillance regulations, general regulations on competencies of the administrative authorities, liability provisions as well as provisions on the payment of fines.

To protect against the hazards arising from radioactive substances and to control their utilisation, the AtG requires that the construction and operation of nuclear installations is subject to regulatory licensing. The AtG regulates, in particular,

- prerequisites and procedures for the granting of licences,
- performance of supervision,
- consultation of authorised experts, and
- charging of procedural costs.

However, most of these regulations stipulated therein are not exhaustive and are further substantiated regarding procedures and substantive legal requirements by ordinances and the non-mandatory guidance instruments. According to § 7 AtG, 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.

In response to the nuclear accident in the Chernobyl nuclear power plant, the Precautionary Radiological Protection Act (StrVG) [1A-5] was promulgated in 1986, which requires the monitoring of radioactivity in the environment both on a continuous basis and continuously and in 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, among others relating to the safety of nuclear installations in support of the nuclear licensing and supervisory authorities, are delegated to this office.

Ordinances

For further specification of the legal regulations, the AtG includes authorisations for issuing ordinances (cf. listing in § 54 para. 1 AtG). These ordinances are issued by the Federal Government, but they require the consent of the *Bundesrat* (German Federal Council). The *Bundesrat* is a constitutional body of the Federation in which the governments of the *Länder* are represented. The applicable ordinances on protective and preventive measures for nuclear installations are listed in Table 7-1.

Table 7-1 Ordinances on protective and preventive measures for nuclear installations

	Brief description on the legislative content
StrlSchV	**Radiation Protection Ordinance [1A-8]** Principles and limits of radiation protection, requirements on organisation of radiation protection, personal monitoring, environmental monitoring, accident management, design against accidents and accident planning values
AtVfV	**Nuclear Licensing Procedure Ordinance [1A-10]** Application documents (one safety analysis report), public participation, safety specifications (operational limits and conditions for safe operation), procedures and criteria for major modifications
AtSMV	**Nuclear Safety Officer and Reporting Ordinance [1A-17]** Position, duties, responsibilities of the nuclear safety officer, reporting of special events in nuclear installations according to § 7 AtG
AtZüV	**Nuclear Reliability Assessment Ordinance [1A-19]** Checking of personal reliability for protecting against the diversion or major release of radioactive material
AtDeckV	**Nuclear Financial Security Ordinance [1A-11]** Financial security pursuant to the AtG
AtKostV	**Cost Ordinance under the AtG [1A-21]** Fees and costs in procedures under nuclear law
KIV	**Ordinance Concerning Potassium Iodide Tablets [1A-20]** Provision and distribution of medicine containing potassium iodide as thyroid blocker in case of radiological events
AtAV	**Nuclear Waste Transfer Ordinance g [1A-18]** Transfer of radioactive wastes into or out of the territory of the Federal Republic of Germany
EndlagerVlV	**Repository Prepayment Ordinance [1A-13]** Advance payments for the erection of federal facilities for the long-term engineered storage and disposal of radioactive waste

General administrative provisions

Ordinances may include additional authorisations for issuing general administrative provisions. General administrative provisions regulate the actions of the authorities, thus only being directly binding 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 (→ Appendix 5, Section 2).

Regulatory guidelines published by the BMUB

After having consulted the *Länder*, the BMUB publishes regulatory guidelines (in the form of requirements, guidelines, criteria 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 AtG.

These publications of the BMUB describe the view of the nuclear licensing and supervisory authority of the Federation and, if the decisions were taken in the LAA, also the view of the nuclear licensing and supervisory authorities of the *Länder* on general nuclear safety issues and administrative practice and serve as orientation for the nuclear licensing and supervisory authorities of the *Länder* regarding the enforcement of the AtG. They are referred to by the competent nuclear licensing and supervisory authorities of the *Länder* within the framework of licensing procedures or their supervisory action under their own responsibility. This ensures that the implementation in the different *Länder* takes place according to comparable standards. In relation to the licence holders of the nuclear installations, these become binding by taking them into account in nuclear licences or orders of the nuclear supervisory body.

The most important nuclear regulations are the “Safety Requirements for Nuclear Power Plants”, including their “Interpretations”. These contain fundamental and overriding safety-related requirements within the framework of the non-mandatory guidance instruments which serve for putting in concrete terms the precaution in line with the state of the art in science and technology against damage caused by the construction and operation of the plant as stipulated in § 7 para. 2, subpara. 3 AtG. With regard to the nuclear installations operated in Germany, this concerns modification licences. Here, the decisions of the Supreme Court on the scope of regulatory examination in modification licensing procedures shall be considered. An update of the “Safety Requirements for Nuclear Power Plants” was published on 30 March 2015. The announcement of the BMUB specifies in what framework these are applied by the *Länder*. As far as necessary from a safety-related point of view, the “Safety Requirements for Nuclear Power Plants” shall also apply to nuclear power plants that pursuant to § 7 para. 1a AtG have had their power operating licences revoked or which due to a decision taken by the licence holder are in their post-operational phase.

Currently, there are more than 100 regulatory guidelines in the field of nuclear technology (→ Appendix 5). These are regulations pertaining to the following:

- “Safety Requirements for Nuclear Power Plants”,
- accident management measures to be planned by the licence holders with regard to postulated design extension conditions,
- 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 installations and research reactors,
- monitoring of emissions and radioactivity in the environment,
- the periodic safety review (PSR) for nuclear installations,

- technical documents to be prepared regarding construction, operation and decommissioning of nuclear installations,
- documents to be supplied with the application for a licence,
- procedures for the preparation and performance of maintenance and modification work in nuclear installations, and
- personnel qualification.

<u>Other non-mandatory guidance instruments on the safety of nuclear installations</u>

Recommendations of the Reactor Safety Commission (RSK), the Nuclear Waste Management Commission (ESK) or the Commission on Radiological Protection (SSK)

The BMUB requests its commissions (RSK, ESK and SSK) for advice on important issues related to licensing and supervisory procedures for nuclear installations in operation, shut down or under decommissioning, the development of rules and regulations or safety research (→ Article 8). In addition, the commissions may also give advice on their own initiative. Depending on the issues to be discussed, the nuclear licensing and supervisory authorities of the *Länder*, the licence holders of the nuclear installations or the industry also participate in the consultations. The consultation results of the commissions are statements or recommendations published by the commissions themselves on their websites after approval by the BMUB. The nuclear licensing and supervisory authorities of the *Länder* review the decisions (recommendations and opinions) of the commissions under their own responsibility in the nuclear licensing and supervisory procedures, in particular for plant-specific relevance. They decide whether, and if so, what action is required in the particular case and initiate any necessary measures.

KTA safety standards

The KTA is established at the BMUB. According to § 2 of its statutes, the KTA has the task to establish safety standards in fields of nuclear technology where consensus is emerging between experts of the manufacturers and operators of nuclear installations and of authorised experts and the authorities, and to support their application. The KTA safety standards specify, among others, the safety requirements of the general guidance instruments (“Safety Requirements for Nuclear Power Plants” and their “Interpretations”) and put them into concrete terms. An office that coordinates the processes of the KTA is led by the BfS.

The KTA and its currently seven subcommittees are composed of representatives of the following five groups: manufacturers of nuclear installations, licence holders of nuclear installations, nuclear licensing and supervisory authorities of the Federation and the *Länder*, consultants and consultancy organisations (authorised experts) and other authorities, organisations and bodies dealing with nuclear technology (e.g. of the trade unions, industrial safety organisations, liability insurers and of nuclear research facilities).

The KTA safety standards are drafted within the framework of the KTA subcommittees in special working groups by experts of the groups, submitted to the KTA by the subcommittees for decision and adopted by the KTA, where the five groups are equally represented, with a total of seven votes each. KTA safety standards will only be adopted if five sixths of the members approve the draft. Thus, no individual interest group voting unanimously can be outvoted by the others.

KTA safety standards are not legally binding, but due to the nature of their origin and their high degree of detail they have a far-reaching practical effect.

Historically, the KTA safety standards have been developed on the basis of applicable national nuclear rules and regulations and on the American nuclear safety standards. The ASME-Code

(American Society of Mechanical Engineers Code) (Section III) was used as a model for 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 field of ageing management which, today, is internationally treated as a separate issue. Furthermore, there are specific KTA standards for management systems and for ageing management.

The KTA programme of standards currently comprises 97 different standards (as of May 2016). 90 of them are applicable KTA safety standards, and seven are standards which are no longer part of the revision process. 24 of the 97 standards are currently in the revision process.

The regulatory power of the legislator and administrative action by the competent nuclear licensing and supervisory authorities are not restricted by the KTA process.

Conventional technical standards

For the construction and operation of nuclear installations, conventional technical standards apply as a supplement. This is particularly the case for the national standards of the German Institute for Standardization (DIN) as well as 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, provisions of the Federation and the *Länder* relating to nuclear law shall not be affected to the extent that other or more stringent requirements are made or permitted by them.

<u>Updating nuclear rules and regulations</u>

National nuclear rules and regulations

The safe operation of nuclear installations is to be ensured, in particular that precautions have been taken as are necessary in the light of the state of the art in science and technology in order to prevent damage caused by the construction and operation of the installation. This also includes an adjustment of the national nuclear rules and regulations as required.

Germany closely follows the development of the IAEA safety standards. Newly published IAEA safety standards are compared with the German rules and regulations. During the reporting period, this did not result in any indications for the need to update the German rules and regulations.

In September 2014, WENRA published a revised version of the “WENRA Safety Reference Levels”. These take into account the lessons learned from the nuclear accident in the Fukushima nuclear power plant. In 2015, Germany carried out a self-assessment as to what extent the revised “Reference Levels” are included in national nuclear rules and regulations. It was found that, in general, there are no gaps in national nuclear rules and regulations and supervisory practices and that adjustments in the national nuclear rules and regulations are only required in some cases. For this purpose, an implementation plan has been created, which is to be implemented by 2017.

The “Safety Requirements for Nuclear Power Plants” and their “Interpretations” are subjected to reviews at regular intervals. Necessary amendments are jointly adopted in the LAA by the BMUB and the nuclear licensing and supervisory authorities of the *Länder* and then published by the BMUB.

The KTA safety standards are subject to regular reviews. The texts of the adopted safety standards are reviewed at least every five years in accordance with the statutes and, where required, adapted to the state of the art in science and technology in terms of the necessary precautions to prevent damage. It is planned to review all KTA safety standards again until the spring of 2018 to achieve validity in accordance with the statutes until at least the end of 2022 (end of power operation of the last nuclear installations in Germany).

Development of international rules and regulations

Experts from Germany participate in the international development of nuclear rules and regulations. On the one hand, the aim is to ensure with the help and support of the international nuclear rules and regulations best possible protection against damages and to effect a comparable further development of the national regulatory framework. On the other hand, these international developments are to make a contribution to European harmonisation. In this respect, the following tasks are performed continuously:

- Active involvement in all IAEA safety standards committees (CSS, NUSSC, RASSC, WASSC, TRANSSC)
- Secondment of technical experts for the development and revision of IAEA safety standards
- Formal public participation in the process of providing comments on IAEA safety standards by the member states. For this purpose, the relevant drafts are published in the Federal Gazette with an invitation to submit comments.
- Preparation of annual summary reports on the work of the IAEA on safety standards. This has been done by the BMUB since 2006
- Participation in the development and revision of the “WENRA Safety Reference Levels”

7 (2ii) System of licensing

General provisions

The granting of a licence for nuclear installations is regulated in the AtG. According to § 7 AtG, a licence is required for the erection and operation of stationary installations for the production, treatment, processing and fission of nuclear fuel or for the reprocessing of spent nuclear fuel. Essential modifications of nuclear installations or their operation as well as the decommissioning of an installation also require a licence from the competent nuclear licensing and supervisory authority. When issuing a licence, obligations may generally be imposed for meeting the protective purpose.

According to § 7 para. 1, sentence 2 AtG, no further licences will be issued for the construction and operation of installations for the fission of nuclear fuel for commercial generation of electricity or of facilities for the reprocessing of spent nuclear fuel. However, the operating licences already granted are not limited in time and do not require any extension or renewal. The authorisation to operate the existing nuclear installations shall expire once the electricity volume for that installation as specified in the AtG or the electricity volume derived from transfers has been produced, but not later than the dates specified for each nuclear installation (§ 7 para. 1a AtG). Accordingly, for nuclear installations, nuclear licensing procedures are only performed for essential modifications (§ 7 para. 1 AtG) and their decommissioning (§ 7 para. 3 AtG).

Thus, the following presentation concentrates on licensing procedures for essential modifications of the existing nuclear installations or their operation. Decommissioning of nuclear installations is the subject of reporting within the framework of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

The planned modifications of a nuclear installation or its operation are to be assessed systematically with regard to their impacts on the necessary protective and preventive measures. As stipulated in § 7 para. 1 AtG, essential modifications of nuclear installations or their operation are subject to licensing. For modifications requiring a licence, the fulfilment of the licensing prerequisites is to be verified according to § 7 para. 2 AtG. Accordingly, a licence may only be granted if

- there are no known facts giving rise to doubts as to the reliability of the applicant and of the persons responsible for the erection and management of the installation and the supervision of its operation, and the persons responsible for the erection and management of the installation and the supervision of its operation have the 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 of 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, and
- the choice of the site of the installation does not conflict with overriding public interests, in particular in view of its environmental impacts.

Modifications of nuclear installations or their operation that are not essential do not require a licence. However, they are reported to the nuclear supervisory authority within the framework of nuclear supervision and may be subject to the accompanying inspections by the nuclear supervisory authorities within the supervisory procedures. Specifications for modification procedures are in place in the written operating procedures of the licence holders.

The actual details and procedure of licensing according to the AtG are regulated more detailed in the AtVfV.

Nuclear licensing procedures

Licence application

The written licence application is submitted to the competent licensing and supervisory authority of that *Land* in which the nuclear installation is sited. Along with the application, the applicant has to submit all documents required for the examination of the licensing prerequisites by the nuclear licensing and supervisory authority and the experts consulted by it. These documents are listed in detail in § 2 and § 3 AtVfV and their form 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. In addition, also those plant components and procedural steps of the licensed plant will be examined on which the modification will have an impact. The documents submitted by the applicant must 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. Moreover, a safety analysis report is to be submitted (§ 3 para. 1, subpara. 1 AtVfV), which is reviewed by the competent nuclear licensing and supervisory authority with the support of authorised experts in the course of the licensing procedure. In addition to the safety analysis report, the applicant also has to submit the following to the nuclear licensing and supervisory authority:

- supplementary plans, drawings and descriptions of the installation and its components,
- information concerning measures provided for the installation and its operation against interference and other intervention by third parties, according to § 7 para. 2, subpara. 5 AtG,
- information enabling the examination of the reliability and expertise of the persons responsible for the construction of the installation and the management and supervision of its operation,
- information enabling a verification as to whether the persons otherwise engaged in the operation of the installation possess the necessary knowledge in accordance with § 7 para. 2, subpara. 2 AtG,
- a schedule containing all the data relevant for the safety of the installation and its operation, the measures to be taken in the event of incidents or damage, and an outline plan of the tests provided for safety-related components of the installation (safety specifications),
- proposals for financial security to cover the legal liability to pay compensation,
- a description of the radioactive residues accumulating as well as data concerning the measures provided for the prevention of any accumulation of radioactive residues, for the safe utilisation of accumulated radioactive residues and dismantled or dismounted radioactive components of the installation in accordance with the purposes referred to in § 1 nos. 2 to 4 AtG, for the disposal of radioactive residues or dismounted radioactive components in a controlled and structured manner in the form of radioactive wastes, including their intended treatment, as well as for the anticipated storage of radioactive wastes until their disposal, and
- data relating to other environmental effects of the project which are required for the examination pursuant to § 7 para. 2, subpara. 6 AtG with respect to approval decisions which, in individual cases, may be included in the licensing decision, or for decisions to be taken by the nuclear licensing and supervisory authority in accordance with provisions relating to the conservation of nature and the maintenance of landscapes.

Examination of the application

On the basis of the submitted documents, the nuclear licensing and supervisory authority assesses whether or not the licensing prerequisites have been met. All federal, *Land*, local and other regional authorities and, according to circumstances also authorities of other states (§ 7a AtVfV), whose jurisdiction is involved shall take part in the licensing procedure. For the assessment of safety issues, it is common practice to engage technical safety organisations to support the nuclear licensing and supervisory authority in the evaluation of the application documents. In written safety evaluation reports, the authorised experts explain whether or not the requirements regarding nuclear safety and radiation protection have been met. The nuclear licensing and supervisory authority assesses and decides on the basis of its own judgement. In making its decisions, it is not bound by the opinions of the authorised experts. Further information on consulting authorised experts is given in the explanations on Article 8.

Within the frame of federal executive administration, the nuclear licensing and supervisory authority of the *Land* informs the BMUB if it considers the licensing procedure to be significant, or if the BMUB issued requirements within the framework of federal supervision (e.g. for power increases applied for). Information is also given if the BMUB deems it necessary to involve the Federation in the individual case.

In performing these safety-related tasks within federal supervision, the BMUB consults its advisory commissions (RSK, ESK and SSK) and in many cases GRS for advice and technical support. Where required, the BMUB states its position on the draft decision to the nuclear licensing and supervisory authority of the *Land*.

Environmental impact assessment

The requirement for an environmental impact assessment for essential modifications of a nuclear installation or its operation as well as the decommissioning of a nuclear installation within the nuclear licensing procedure is regulated in the Act on the Assessment of Environmental Impacts (UVPG) [1B-3] in conjunction with § 2a AtG and provisions of the AtVfV, which is based on the AtG. The competent nuclear licensing and supervisory authority carries out 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 effective environmental protection (§ 6 para. 1, subpara. 3 in conjunction with § 3 para. 4 AtVfV). In addition, the applicant has to prepare a safety analysis report (§ 6 para. 1, subpara. 2 in conjunction with § 3 para. 1, subpara 1 AtVfV) that is reviewed by the competent nuclear licensing and supervisory authority with the support of authorised experts in the course of the licensing procedure. The safety analysis report also serves to allow third parties to assess whether their rights could be violated by effects associated with the installation and its operation or by essential modifications.

Public participation

The purpose of public participation is to enable the citizens 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 foresee public participation if the modification will have no adverse effects on the public. However, the public has to be involved if this is required pursuant to the UVPG. The AtVfV includes detailed regulations on

- the conditions under which the nuclear licensing and supervisory authority may foresee public participation or must involve the public,
- 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 (§§ 4-7a AtVfV), and
- holding a public hearing where the objections are discussed between nuclear licensing and supervisory authority, licence applicant and the persons who have raised the objections (§§ 8-13 AtVfV).

The nuclear licensing and supervisory authority considers and evaluates the objections from public participation in its decision-making and states the reasons for the decision.

If the licensing procedure is conducted with public participation, the applicant shall submit a brief, readily comprehensible description of the installation and the modification 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 nuclear licensing and supervisory authority and the authorised experts (§ 6 para. 1, subpara. 3 in conjunction with § 3 para. 4 AtVfV). In addition to public participation in the licensing procedure, the laws of the *Länder* generally provide for public participation at an early stage during which the project implementer informs the public about the project already before application and provides the opportunity for comments and discussions.

Licensing decision

The final decision of the nuclear licensing and supervisory authority is based on the entirety of application documents, safety evaluation reports by the authorised experts and, if available, the statement by the BMUB and the authorities involved as well as the findings from objections raised in the public hearing. Prerequisite for the legality of the decision is that all procedural requirements of the AtVfV are fulfilled. The decision of the nuclear licensing and supervisory authority can be appealed before administrative courts.

The AtG includes the necessary authorisation providing the basis for the licensing and supervisory authorities of the *Länder* to take action against an unlicensed construction or unlicensed operation of a nuclear installation. In particular, the nuclear licensing and supervisory 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. This applies if a required licence had not been granted by the nuclear licensing and supervisory authority or if the required licence had been revoked. The nuclear licensing and supervisory authority does not only have these powers in cases where 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 (2iii) Regulatory inspection and assessment (supervision)

After the necessary licence has been granted, nuclear installations are subject to continuous regulatory supervision in accordance with the AtG and associated ordinances over their entire lifetime from the start of construction to the end of decommissioning. This supervision is performed by the nuclear licensing and supervisory authorities of the *Länder* on behalf of the Federation. 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 nuclear licensing and supervisory authority. As in licensing, the supreme objective of regulatory supervision of nuclear installations is to protect the general public and the people working in these installations against the risks associated with the operation of the installation. On-site supervisory activities of the nuclear licensing and supervisory authority are performed, on average, once per week and installation. The nuclear licensing and supervisory authority pays particular attention to

- the fulfilment of the requirements of the AtG, the ordinances issued under the AtG and the other nuclear safety standards and guidelines,
- the fulfilment of the provisions, obligations and ancillary provisions imposed in the licence notices, and
- the fulfilment of any supervisory order.

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

- compliance with the safety-relevant operating procedures,
- the performance of in-service inspections of safety-relevant components and systems,
- the evaluation of reportable events,
- the implementation of modifications of the nuclear installation or its operation,
- radiation protection monitoring of personnel in nuclear installations,
- radiation protection monitoring in the vicinity of the nuclear installation, including the operation of the remote monitoring system for nuclear power plants (KFÜ), being independent from the licence holder,
- compliance with the plant-specific authorised limits for radioactive discharges,

- the measures taken against disturbers or other interference by third parties,
- the reliability of the licence holder,
- the technical qualification and the maintenance of the qualification of the responsible persons as well as of the knowledge of personnel otherwise engaged in the installation, and
- the quality assurance measures.

The involvement of the different management levels of the licence holder is always ensured. During plant revisions with refuelling outages and after reportable events, on-site supervision also takes place every working day or permanently.

The authorised experts of the nuclear licensing and supervisory authority are on site more frequently and have, according to the AtG, access to the nuclear installation at any time and are authorised to perform necessary examinations and to demand pertinent information (§ 20 in conjunction with § 19 para. 2 AtG). The nuclear licensing and supervisory authority is not bound by the result of the examinations.

The licence holders of the nuclear installations have to submit written operating reports to the nuclear licensing and 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 radiologically and safety-relevant events must be reported to the nuclear licensing and supervisory authorities according to the provisions specified in the AtSMV. The regulations and procedures regarding reportable events and their evaluation are described in the explanations on Article 19 (iv) - (vii). In addition, the licence holders 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 are also regulated by law in § 19a AtG (→ Article 14 (i)).

7 (2iv) Enforcement of regulations and provisions

Enforcement by regulatory order, particularly in urgent cases

According to § 19 AtG, the nuclear licensing and supervisory authority may order that the licence holder discontinues a situation which is contrary to the provisions of the AtG, the ordinances issued under the AtG, the terms and conditions of the licence or to any subsequently imposed obligation, or which may constitute a hazard to life, health or property due to the effects of ionising radiation. Depending on the specific circumstances of the individual case, it may, in particular, order that

- specific protective measures shall be taken,
- radioactive material shall be stored or kept in custody at a place designated by it,
- the handling of radioactive material, the erection and operation of installations of the kind referred to in §§ 7 and 11 para. 1, subpara. 2 AtG as well as the handling of installations, equipment and devices of the kind referred to in § 11 para. 1, subpara. 3 AtG shall be suspended or, if a requisite licence has not been granted or definitely revoked, discontinued.

The powers of the nuclear licensing and supervisory authority in case of an unlicensed mode of operation are dealt with in Article 7 (2ii).

In case of non-fulfilment of the licensing provisions or supervisory orders, the nuclear licensing and 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 § 17 AtG, 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 installation or the general public which cannot be removed within a reasonable time by appropriate measures, then the nuclear licensing authority must 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 licence holder violates legal regulations or decisions by the authorities.

Prosecution of violations of nuclear law provisions

The Criminal Code (StGB) [1B-11], the AtG and the ordinances issued under the AtG provide sanctions to prosecute violations.

Criminal offences

Any violation that must be considered as a criminal offence is dealt with in the StGB. Whosoever, e.g.,

- operates, otherwise holds, modifies or decommissions a nuclear installation without the required licence (§ 327 StGB),
- knowingly constructs a defective nuclear installation (§ 312 StGB),
- handles nuclear fuel without the required licence (§ 328 StGB),
- releases ionising radiation or causes nuclear fission processes capable of damaging life and limb of another person (§ 311 StGB), and
- procures or manufactures nuclear fuel, radioactive materials or other equipment for himself in preparation of a criminal offence (§ 310 StGB)

shall be liable to imprisonment or a fine.

Administrative offences

§§ 46 and 49 AtG and the associated ordinances deal with administrative offences and provide for the imposition of fines on the acting persons. An administrative offence is committed by any person who, e.g.,

- erects installations for the fission of nuclear fuel without a licence,
- acts in violation of a regulatory order or obligation imposed,
- handles radioactive material without a licence, and
- as the responsible person fails to ensure compliance with the provisions on monitoring and protection of the StrlSchV.

The AtG and the associated ordinances require designating the persons who are responsible for the handling of radioactive material, for the operation of nuclear installations and for their surveillance. In case of administrative offences, fines of up to 50,000 euros may be imposed on a person committing such an offence. A legally effective fine imposed may put in question the personal reliability that was a prerequisite for the licence and may therefore require the replacement of the responsible person.

Experiences

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 nuclear licensing and supervisory authorities have appropriate sanction possibilities and powers for the enforcement of regulations and provisions, if required.

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.

8 (1) Authorities, committees and organisations

Composition of the regulatory body

Germany is a republic with a federal structure and is composed of 16 federal states, referred to as the *Länder*. Unless otherwise specified, the execution of federal laws generally lies within the responsibility of the *Länder*. The “regulatory body” is therefore composed of the nuclear licensing and supervisory authorities of the Federation and the *Länder* (→ Figure 8-1).

By organisational decree, the Chancellor designates the federal ministry competent for nuclear safety and radiation protection. This competence and thus the responsibility for organisation, staffing and material resources of the nuclear licensing and supervisory authority of the Federation lies with the BMUB. The necessary human and financial resources are applied for by the BMUB from the annual federal budget.

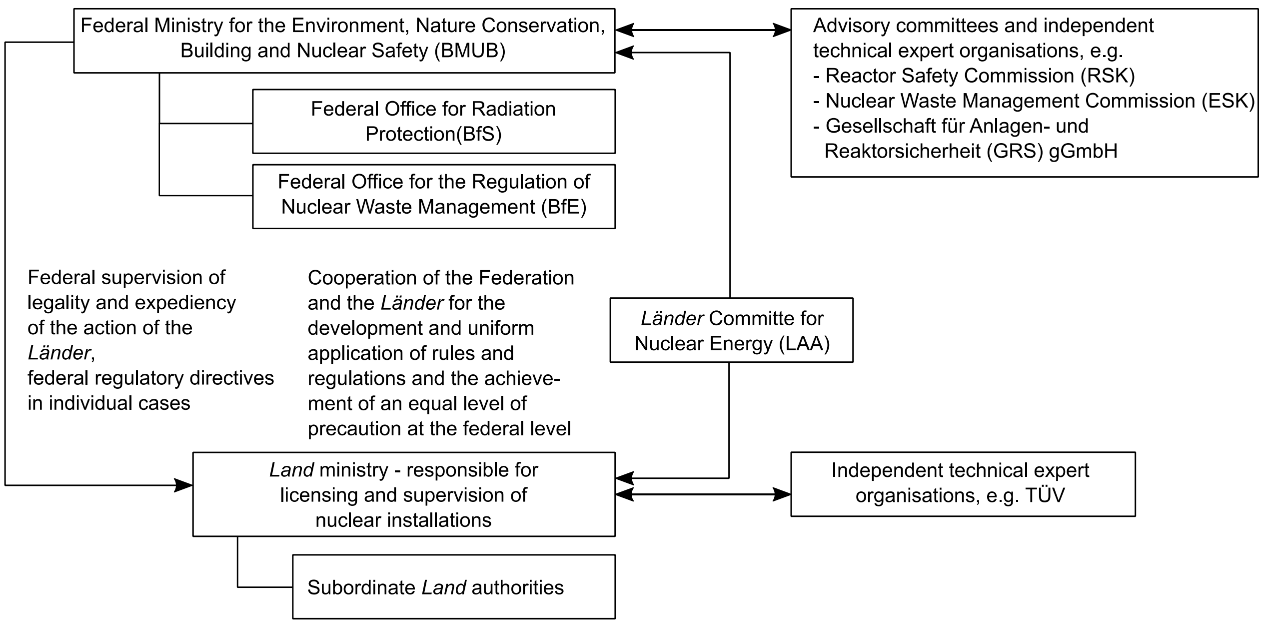

Figure 8-1 Structure of the regulatory body

Regarding the obligations under the “Convention on Nuclear Safety”, the BMUB carries overall state responsibility towards the interior of Germany as well as towards the international community. It ensures that those in charge of the applicants and licence holders, federal and *Land* authorities, and of the technical safety organisations ensure effective protection of man and the environment against the hazards of nuclear energy and the harmful effects of ionising radiation at any time.

According to § 24 AtG, the respective governments of the *Länder* designate the supreme *Land* authorities responsible for nuclear licensing and supervision. Hence, the responsibility for organisation, staffing and material resources of these executive authorities lies solely with the respective governments of the *Länder*. In individual cases, subordinate authorities may also be tasked with supervisory functions. Further regulations are in place for the responsibilities of the Federal Office for Radiation Protection (BfS) in § 23 AtG and the Federal Office for the Regulation of Nuclear Waste Management (BfE) in § 23d AtG.

Assignment of functions and competencies of the regulatory body to the nuclear licensing and supervisory authorities of the Federation and the *Länder*

The responsibility for performance and implementation of the tasks described above primarily lies with the BMUB and the competent nuclear licensing and supervisor authorities of the *Länder*. According to Article 7 (2ii) - (2iv), this regulatory body has to fulfil four basic functions:

- establishment of safety requirements and regulations,
- implementation of licensing procedures,
- regulatory review and assessment, and
- enforcement and inspection.

From the articles of the Convention listed below, further functions are derived that are to be fulfilled by the regulatory body:

- regulatory safety research (Articles 14, 18, 19),
- system for the application of operating experience (Article 9),
- radiation protection (Article 5),
- emergency preparedness (Article 16), and
- international cooperation (Preamble vii and viii, Article 1).

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

As a matter of principle, the licensing and supervisory authorities of the Federation and the *Länder* are involved in all regulatory functions, albeit with different competencies, responsibilities and duties to cooperate. This distribution is shown in Table 8-2. Further details are provided in the relevant articles.

Challenge 7: Common understanding of regulatory nuclear supervision

Based on the recommendations of the IRRS mission in 2008 and the follow-up mission in 2011, the core processes of supervision of nuclear installations (power operation and post-operational phase) and the interfaces between nuclear regulatory supervision of the Federation and the *Länder* were compiled in a handbook on cooperation between the Federation and the *Länder* in nuclear law (supervision manual). The supervision manual was discussed in November 2015 by the FARS in the LAA and is expected to be adopted in 2016 as a joint basis for action and cooperation.

<u>Subordinate authorities of the Federation</u>

Federal Office for Radiation Protection (BfS)

The subordinate authority of the BMUB in the area of radiation protection and nuclear safety is the BfS. The four technical departments of the BfS deal with the statutory tasks 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” department. It supports the BMUB technically and scientifically, especially in the execution of supervision of legality and expediency, the preparation of legal and administrative procedures, and in intergovernmental cooperation.

Federal Office for the Regulation of Nuclear Waste Management (BfE)

With the adoption of the StandAG of 23 July 2013, the procedure has been established for searching a site for the disposal of high-level radioactive waste. According to this Act, the BfE took up its work on 1 September 2014. As another subordinate authority of the BMUB, the BfE shall exercise administrative tasks of the Federation in the area of licensing of federal facilities for the safekeeping and disposal of radioactive waste. The BfE shall provide technical and scientific support to the BMUB and also perform duties of the Federation in these fields on behalf of the BMUB.

Subordinate authorities in the Länder

Since the responsibility for nuclear licensing and supervision is assigned to the supreme authorities of the *Länder* (ministries), only a few tasks are fulfilled by subordinate authorities of the *Länder*, e.g. the KFÜ.

Table 8-1 Competent nuclear licensing and supervisory authorities of the *Länder* with nuclear installations in terms of the Convention

<table>
<tr><th>Land</th><th>Nuclear installation</th><th>Licensing authority</th><th>Supervisory authority</th></tr>
<tr><td>Baden-Württemberg</td><td>GKN I
GKN II
Philippsburg 1
Philippsburg 2
Obrigheim</td><td>Ministry of the Environment, Climate Protection and the Energy Sector of Baden-Württemberg in agreement with the Interior Ministry of Baden-Württemberg</td><td>Ministry of the Environment, Climate Protection and the Energy Sector of Baden-Württemberg</td></tr>
<tr><td>Bayern</td><td>Isar 1
Isar 2
Grafenrheinfeld
Gundremmingen B
Gundremmingen C</td><td colspan="2">Bavarian State Ministry of the Environment and Consumer Protection</td></tr>
<tr><td>Hessen</td><td>Biblis A
Biblis B</td><td colspan="2">Hessian Ministry of the Environment, Climate Protection, Agriculture and Consumer Protection</td></tr>
<tr><td>Niedersachsen</td><td>Unterweser
Grohnde
Emsland</td><td colspan="2">Lower Saxony Ministry for the Environment, Energy and Climate Protection</td></tr>
<tr><td>Schleswig-Holstein</td><td>Brunsbüttel
Krümmel
Brokdorf</td><td colspan="2">Ministry of Energy Transition, Agriculture, the Environment and Rural Areas Schleswig Holstein</td></tr>
</table>

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

Regulatory function	Tasks and competencies of the regulatory body	
	Authorities of the Federation	**Authorities of the *Länder***
Main functions		
Establishment of national safety requirements and regulations [Art. 7 (2i)]	Further development of the legal requirements (decision by the *Bundestag* in the case of formal Acts, by Federal Government with approval of the *Bundesrat* in the case of ordinances) and the national nuclear rules and regulations	Participation on the basis of consolidated findings and needs in connection with execution; supplementary administrative procedures of the respective *Länder*
Licensing system for nuclear installations [Art. 7 (2ii)]	Supervision of legality and expediency* Checking of consolidated findings with regard to their relevance for standard national requirements	Checking of applications and notifications according to § 7 AtG, granting of licences and approvals
System of regulatory inspection and assessment of nuclear installations [Art. 7 (2iii)]		Controls and inspections in the nuclear installations, checking and assessment with regard to the relevance for the safety of the nuclear installation as well as for protective and preventive measures
Enforcement of applicable regulations and of the terms of licences [Art. 7 (2iv)]		Implementation of necessary measures to avert hazards and for necessary safety improvements as well as improvement of protective and preventive 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 relevance for the safety of the nuclear installations as well as to protective and preventive measures, national organisation of experience feedback	Examination and assessment of events with regard to relevance for the safety of the nuclear installations as well as for protective and preventive 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 cooperation	Participation in international activities to determine the state of the art in science and technology and regarding the national nuclear rules and 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 cooperation with neighbouring countries in the case of nuclear installations in border regions, especially on the basis of bilateral agreements

blue — Leading function, execution within the area of competence
light blue — Function with separate competences but common objectives
white — "Federalism function", supervision with regard to legality and expediency or participation

* This also means that the Federation may execute its power to decide on the merits of the case itself and initiate the related detailed examinations on its own authority.

Cooperation of the authorities of the Federation and the *Länder* (regulatory body) – *Länder* Committee for Nuclear Energy (LAA)

The LAA is a permanent Federation-*Länder* committee composed of representatives from nuclear licensing and supervisory authorities of the *Länder* and the BMUB. It serves the purpose of preparatory coordination of activities of the Federation and the *Länder* in connection with the execution of the AtG as well as the preparation of amendments and the further development of legal and administrative provisions as well as of the non-mandatory guidance instruments. In the interest of an execution of nuclear law that is as uniform throughout Germany as possible, the competent nuclear licensing and supervisory authorities of the *Länder* and the BMUB draft regulations in consensus for the uniform handling of nuclear law. These regulations are then promulgated by the BMUB. The BMUB chairs the LAA and also manages its affairs. The LAA's decisions are usually taken by mutual consent.

The LAA (→ Figure 8-2) consists of four technical committees for issues relating to legal matters, nuclear safety, radiation protection and fuel cycle matters. Furthermore, working groups are assigned to these technical committees for special permanent tasks. If needed, the technical committees may set up ad hoc working groups for special and, in particular, 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 once a year.

The discussions in the LAA are an important instrument of early and full involvement of the *Länder* which supplements the formal right of participation of the *Länder* in the legislative procedure of the *Bundesrat*.

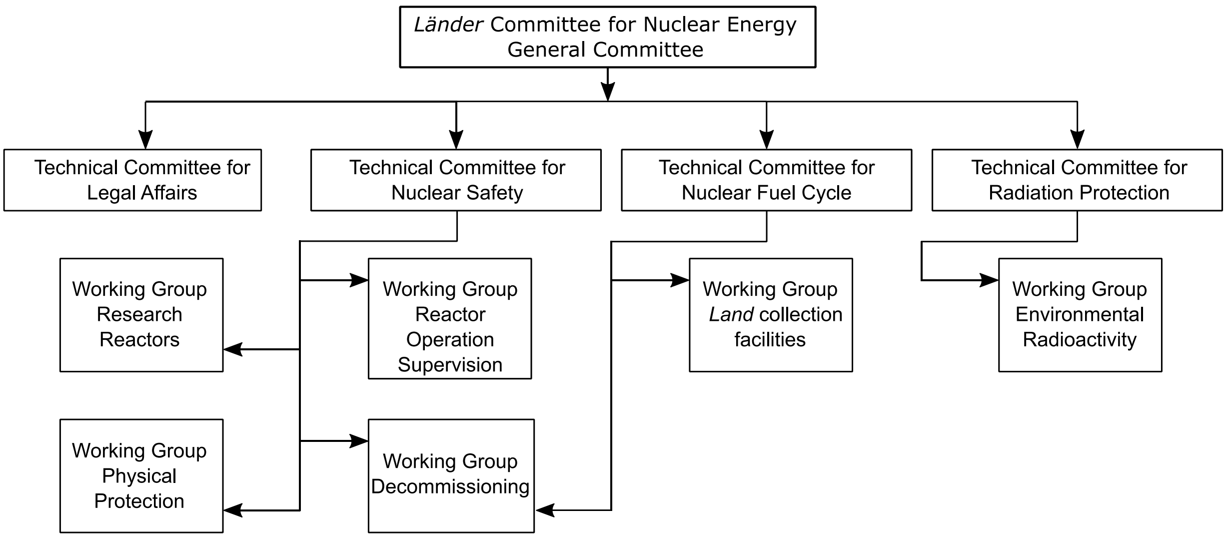

Figure 8-2 Structure of the *Länder* Committee for Nuclear Energy (LAA)

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

Nuclear regulatory authority of the Federation

The nuclear regulatory authority of the Federation is the BMUB, Directorate-General RS “Safety of Nuclear Installations, Radiological Protection, Nuclear Fuel Cycle” of the BMUB. It comprises three directorates. These, in turn, comprise work units (working groups, divisions). Figure 8-3 shows the structure of Directorate-General RS with the three directorates and their work units.

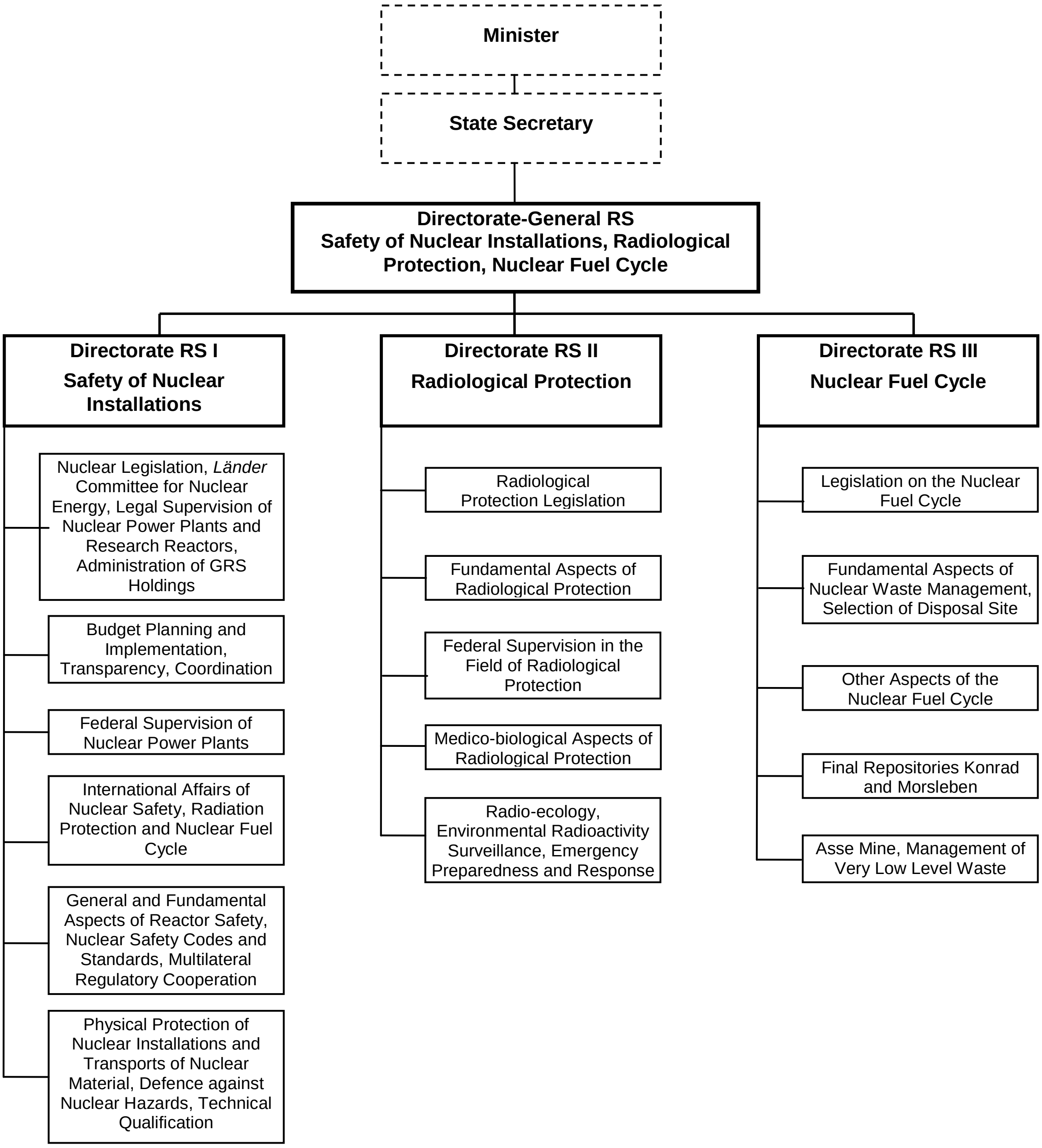

Figure 8-3 Organisation of Directorate RS at the BMUB

The staff of the BMUB is composed of civil servants appointed for life and public service employees.

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 Directorate-General RS are required to have completed university studies with a Master’s degree (senior service) or studies at a university of applied sciences or university studies completed with a Bachelor’s degree (higher service). Apart from that, there are no relevant regulations on training and qualification.

At the BMUB, the responsibility for fulfilling the obligations under the Convention primarily lies with Directorate RS I. The staffing of Directorate RS I (permanent positions) with legal experts (including higher-service staff of other non-technical disciplines) and with scientific and technical experts of higher and senior service is shown in Figure 8-4.

Directorate RS I
Safety of Nuclear Installations
1 legal staff
1 administrative staff

	RS I 1 Nuclear Legislation	RS I 2 Coordination	RS I 3 Federal Supervision	RS I 4 International Aspects	RS I 5 Fundamental Aspects	RS I 6 Physical Protection
Legal experts	5	2	-	2	-	-
Scientific and technical experts	2	0	10	3	6	6

Figure 8-4 Organisation and staffing of Directorate RS I

In Directorate RS II "Radiological protection", another 18 employees are entrusted with tasks that are related to the Convention, e.g. with radiation protection in nuclear installations or emergency preparedness and response.

Nuclear licensing and supervisory authorities of the *Länder*

The nuclear licensing and supervisory authorities of the *Länder* for the supervision of nuclear facilities are the ministries (supreme *Land* authorities) determined by the *Land* governments. Table 8-1 shows the ministries competent for nuclear installations in terms of the Convention. Within the ministries, the tasks of the nuclear licensing and supervisory 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 individual *Land*. These directorates are in turn subdivided into divisions for the execution of the licensing and supervisory procedures for the nuclear installations and are supported, where necessary, by additional divisions dealing with radiation protection and environmental radioactivity, waste management, fundamental issues and legal affairs. In some *Länder*, nuclear fuel cycle facilities not pertaining to the scope of the Convention have to be supervised in addition to nuclear installations and research reactors.

The directorate for the supervision of nuclear facilities is usually supported by a further organisational unit of the ministry which is, in many cases, a directorate for central tasks (e.g. human resources and budgetary affairs, infrastructure tasks and general services). For illustration purposes, Figure 8-5 shows the basic organisation of a *Land* ministry directorate for the supervision of nuclear installations.

The directorates for the supervision of nuclear installations mainly employ technical specialist staff, especially engineers and scientists. They also have legal experts and administrative staff. All these directorates carry out reviews and assessments as well as tasks related to the execution of the nuclear licensing and supervisory procedure as described more detailed in the following articles. There is no strict allocation of staff to the tasks "review and assessment" and "licensing" or to "inspection".

When recruiting new staff and in connection with further qualification, the nuclear licensing and supervisory authorities take care that they have their own expert personnel in the specialist fields that are important for nuclear safety. In Baden-Württemberg, for example, the Nuclear Energy Supervision and Radiation Protection Division implemented regulations for staffing and further qualification measures for the personnel in the management system of the division. Regarding the recruitment and further qualification of staff, a catalogue of competences was introduced, comprising eight competence areas. This catalogue is used to ensure the division's requisite competence and qualification in the context of recruiting and further qualification. Furthermore, the staff is tasked with the management and assignment of the authorised experts consulted as well as with the review and assessment of authorised experts' statements.

Regarding the staffing of the nuclear licensing and supervisory authorities of the *Länder*, it has to be taken into account that according to § 20 AtG authorised experts may be consulted in the nuclear administrative procedure. The nuclear licensing and supervisory authorities of the *Länder* make use of this option regularly and extensively due to the large extent of the inspections and the associated wide range of different scientific and technical disciplines required as well as the special technical equipment needed. To carry out the nuclear licensing and supervisory procedures, about 30-40 persons are required for one single nuclear installation per year. This includes the work of the authority staff and of the authorised experts consulted.

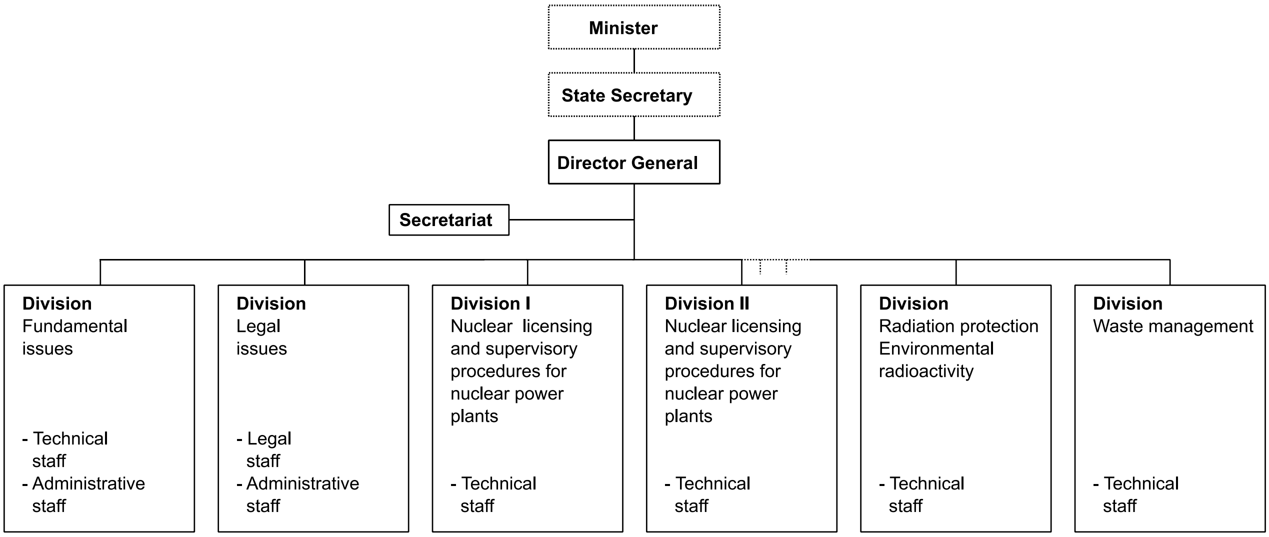

Figure 8-5 Basic organisation of a *Land* ministry directorate for the supervision of nuclear installations

Competence of the regulatory body staff

Already in its former reports under the Convention on Nuclear Safety, the Federal Government always affirmed that efficient and competent regulatory supervision is necessary for the remaining period of operation of the nuclear installations and during their decommissioning. To ensure this, the authorities responsible in Germany guarantee the necessary financial resources, the technical competence of their staff, the required number of staff as well as an expedient and effective organisation.

A large number of experienced staff 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 licensing and supervisory authorities, which have to compensate the loss of informed and experienced staff by suitable measures in order to maintain the competence of the regulatory body in the field of nuclear safety and radiation protection. Positions that become vacant, in particular at the nuclear licensing authorities of the Federation (BMUB, BfS), are usually refilled with university graduates without any special nuclear knowledge.

Competence and personnel development at the nuclear regulatory authority of the Federation

So far it has largely been possible to compensate any loss of experience by the documentation of knowledge, by interviewing those who were about to retire and by the commitment of the junior staff.

An employment condition for technical staff is a university degree in the relevant discipline. The knowledge needed for the special tasks (expert nuclear knowledge, administrational knowledge, etc.) is imparted – where required – in special courses during an introductory phase as well as by on-the-job training at the authorities.

The technical qualification and further education of staff is mainly performed by attending seminars of the expert organisation GRS, by simulator and glass model training at the Gesellschaft für Simulatorschulung (GfS) and participation in external national and international specialist events. Issues of further qualification are addressed, among other things, in the cooperation talks regularly held between all staff members, also long-standing and experienced staff, and executives.

Competence and personnel development at the nuclear licensing and supervisory authorities of the *Länder*

The nuclear licensing and supervisory authorities of the *Länder* are also faced with special challenges with regard to the maintenance of competence. Special efforts are still required to obtain the necessary staffing levels and to ensure the timely introduction of junior staff.

Newly recruited staff members take part in the knowledge transfer of the nuclear licensing and supervisory authorities. They receive training on the basis of individual 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, junior staff are trained in all relevant technical and legal areas.

In addition, also the long-standing and experienced staff of the nuclear licensing and supervisory authorities keep their technical qualification continuously up to date and participate in the relevant training activities.

Training on power plant simulators and on the glass model of the Kraftwerksschule of VGB, illustrating thermal-hydraulic effects in a PWR, are important elements of training and further qualification for all staff members.

The glass model is a glass-made model of a two-loop PWR as it has been manufactured by Kraftwerk Union AG (KWU). The 1:10 scale model has been constructed according to the rules of the similarity theory and enables the visualisation and monitoring of thermal-hydraulic phenomena, such as

- dual-phase natural circulation,
- dual-phase energy transport (reflux condenser),
- water hammers in the loop pipes,
- separation of water with different densities,
- convective heat transfer,
- subcooled boiling, and
- nucleate boiling.

The training programme includes seminars for authority staff conducted by GRS at regular intervals on behalf of the BMUB for training and further qualification especially for junior staff and on various safety issues as well as the seminars and workshops of the Association of Technical Inspection Agencies (VdTÜV). Another important element of training and further qualification is the participation in national and international specialist conferences.

An employment condition for technical staff is a degree from a university of applied sciences or a university degree. Here, relevant professional experience in trade supervision, at authorised expert organisations, in industry and in science is of advantage. The knowledge needed for the special tasks of the nuclear licensing and supervisory authority (expert nuclear knowledge, administrational knowledge, competencies for inspection activities, etc.) is imparted in special courses during an introductory phase as well as by on-the-job training at the nuclear licensing and supervisory authority. Work performance and work results are continuously checked by the superior. Further qualification is addressed in regular appraisal interviews.

The fact that authorised experts are consulted for various different licensing and supervisory procedures demands that the regulatory officials have a broad, generalist knowledge. For example, they have to verify whether the authorised experts' statements cover all relevant areas and have to come to an administrative decision on the basis of different statements. Some nuclear licensing and supervisory authorities of the *Länder* have appointed so-called technical coordinators which have special knowledge in individual fields.

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

For support and for the preservation of knowledge at the BMUB, the *Länder*, technical safety organisations and other scientific and technical institutions of nuclear safety, an institution-wide web-based portal for nuclear safety was introduced as an instrument of knowledge management. The portal is operated and managed by GRS on behalf of the BMUB. On the one hand, it provides knowledge pages on selected topics and, on the other hand, collaboration pages where, for example, meeting documents of Federation-*Länder* committees are made available, and it includes areas where documents and results of research and development projects financed by the BMUB and other federal departments are documented (project pages). For the knowledge pages, compilations of documents and technical information relevant for nuclear authorities and expert organisations are prepared and provided in an electronically structured form.

The international exchange of information and knowledge for the effective and transparent execution of the AtG and regulatory cooperation is becoming increasingly important. Therefore, the BMUB also uses international information networks (such as the International Regulatory Network (Reg-Net) or the Global Nuclear Safety and Security Network (GNSSN)) and is actively involved in their design.

Financial resources of the regulatory body

The financial means available to the nuclear licensing and supervisory authorities for their own personnel and for the consultation of authorised experts are fixed by the *Bundestag* and the *Land* parliaments in their respective budgets. The applicants and licence holders are invoiced by the *Länder* for the project-specific costs of nuclear licensing and supervision. There is no refinancing of the activities of the nuclear licensing and supervisory authority of the Federation (BMUB), since the licence holders of the nuclear installations cannot be charged with fees for the supervision of the nuclear federal authority through the *Land* authorities.

Licences for nuclear installations and the supervisory activities of the *Länder* are generally subject to charging. The amount of fees is fixed by law in the AtKostV. The costs are paid by the licence holder to the treasury of the respective *Land*. A modification requiring a licence costs between 500 euros and 1,000,000 euros. The costs of supervision are invoiced according to the actual effort for the individual activities and lie between 25 euros and 500,000 euros. The remuneration for the authorised experts consulted is also reimbursed by the applicant or licence holder as expenses.

The BMUB can dispose of an approximate annual 31.5 million euros from the federal budget for studies in the fields of nuclear safety, radiation protection and nuclear supply and waste management. The field of nuclear safety includes the evaluation and assessment of operating experience, studies on special safety-related issues and further development of technical requirements for nuclear facilities as well as work on technical and other specific questions in connection with the licensing and supervision of nuclear installations. Further funds from the budget are used, among other things, for financing the work of the advisory committees and for involving external experts in international cooperation.

Management systems of the regulatory body

Management system at the nuclear regulatory authority of the Federation

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

For Directorate-General RS, this general basis is supplemented by instruments of planning and strategy development as well as a description of the main processes that are available to all members of Directorate-General RS in an electronic manual.

The aim of the management system in the form selected is the early identification of future requirements, thus enabling targeted and timely action. It is intended to support management staff in carrying out their management duties and help to increase the quality and efficiency of work. Furthermore, the documentation of the processes and work instructions ensures that experiences with internal processes is passed on specifically and is not lost due to the retirement of staff.

Management systems at the nuclear licensing and supervisory authorities of the *Länder*

The work routines and processes of the nuclear licensing and supervisory authorities of the *Länder* are largely defined and regulated uniformly by the established organisational procedures for *Land* ministries. However, individual aspects of these management systems are also adapted specifically in the various authorities on a continuous basis, taking into account changing requirements. Here, the activities are focused on the description and analysis of process sequences in nuclear licensing and supervisory procedures.

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

Federal Office for Radiation Protection (BfS)

The support of the BMUB by the BfS is provided by several of its departments. For issues related to the Convention on Nuclear Safety, support is mainly provided by the Department SK “Nuclear Safety”.

Priority issues related to the Convention on Nuclear Safety are

- the documentation of the licensing status and the remaining electricity production rights of nuclear installations,
- the documentation and initial assessment of reportable events,

- the methods and status of the safety reviews,
- selected safety issues,
- international cooperation,
- national and international rules and regulations,
- keeping of a register of occupational radiation exposure,
- the control programme for emission monitoring of nuclear installations,
- large-scale monitoring of environmental radioactivity, and
- the support and administration of regulatory study projects.

Kind and extent of the support is coordinated between the BMUB and the BfS on an annual basis as part of their annual planning.

Reactor Safety Commission (RSK), Nuclear Waste Management Commission (ESK), Commission on Radiological Protection (SSK)

The BMUB receives advisory support from the RSK, the ESK and the SSK on a regular basis. It has to be ensured that the commissions are independent and well qualified and that the whole spectrum of scientific and technical opinions is reflected. The members are obliged to express their opinions in a neutral and scientifically sound manner. The commissions currently consist of 14 to 17 members from different disciplines. The members are appointed by the BMUB. The main focus of their activities is on providing advice on issues of fundamental importance and on initiating further developments in safety technology. The results of the consultations of the commissions are formulated as general recommendations and as statements on individual cases, which are then published (www.rskonline.de, www.entsorgungskommission.de, www.ssk.de).

Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH

GRS is a central research and expert organisation in the field of nuclear safety. GRS conducts scientific research in the field of nuclear safety, mainly on behalf of the BMWi and the BMUB, and is the central expert organisation advising the BMUB on technical issues. To a very limited extent, GRS also works on behalf of the nuclear licensing and supervisory authorities of the *Länder*. GRS has about 350 technical and scientific staff in the fields of nuclear safety and physical protection, radiation and environmental protection as well as the management of radioactive and chemically toxic waste.

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 to improve the quality, safety and reliability of such facilities by introducing independent supervision.

The special technical knowledge and independence are the decisive criteria for the consultation of authorised experts. Today, this is mainly ensured by the technical inspections agencies (TÜV) but also by other expert organisations or individual experts for specific issues. These work on behalf of the nuclear licensing and supervisory authorities of the *Länder*.

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 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 the VdTÜV.

In performing their nuclear licensing and supervisory activities, the *Land* ministries (*Land* authorities) may consult technical safety organisations or individual authorised experts (§ 20 AtG).

Authorised experts are consulted for almost all technical issues to assess the safety of nuclear installations and their operation. They are particularly involved in the nuclear licensing procedures as well as in the supervisory procedures.

In making their decisions, the nuclear licensing and supervisory authorities of the *Länder* are not bound by the statements of the authorised experts. They have the necessary competences to fulfil their functions, which also includes the management of the authorised experts consulted.

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

- training,
- professional knowledge and skills,
- reliability, and
- impartiality,

are specified in guidelines.

With the involvement of authorised expert, an examination on the safety-related issues is made which is independent of that of the applicant. For this purpose, the authorised experts conduct their own checks and calculations, preferably with methods and computer codes different from those used by the applicant. The persons involved in preparing the expert opinions are not bound by any technical instructions. They are reported to the respective nuclear licensing and supervisory authority by name or are known to it.

The scope of expert services is always determined by the competent nuclear licensing and supervisory authority.

For its supervisory activities, the BMUB will equally consult national and international external experts if necessary, in addition to those of GRS.

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

At the invitation of the BMU, an IAEA-IRRS mission to Germany took place at Directorate General RS of the BMU and at the Ministry of the Environment, Climate Protection and the Energy Sector of the *Land* of Baden-Württemberg (UM BW), Division 3, from 7 to 19 September 2008. It was the first IRRS mission reviewing the nuclear licensing and supervisory authorities in Germany.

The accident at the Japanese Fukushima nuclear power plant on 11 March 2011 and its serious consequences led to the follow-up mission being postponed from June to September 2011. In addition, the IAEA had introduced a new “Interdisciplinary Module” on regulatory activities in the wake of the Fukushima accident. In its form at that time, it covered all modules and dealt with the specific requirements for the nuclear licensing and supervisory authorities that had been derived from the lessons learned until then. In June 2011, the IAEA asked Germany to prepare this module for the follow-up mission in September, too, and submit a supplementary report on it.

Apart from reviewing the implementation of the recommendations and suggestions of the 2008 mission, the reviewers additionally and for the first time examined the follow-up activities of the German nuclear licensing and supervisory authorities after the Fukushima accident.

In 2008, the UM BW took part in the IRRS mission to represent the nuclear licensing and supervisory authorities of the *Länder*. In the follow-up mission, further nuclear licensing and supervisory authorities of the *Länder* where nuclear installations are operated (Bavaria, Hesse, Lower Saxony and Schleswig-Holstein) also took part as observers.

The reports of the 2008 IRRS mission and of the follow-up mission were published on the websites of the BMUB (www.bmub.bund.de) and the UM BW (www.um.baden-wuerttemberg.de).

Based on Directives 2009/71/EURATOM and 2014/87/EURATOM of 25 July 2014, Germany committed itself, like all other EU member states, to host an IRRS mission every ten years. To this end, ENSREG and the IAEA signed a "Memorandum of Understanding" and established a European IRRS programme. In this programme, another IRRS follow-up mission in Germany is provided for 2018.

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

8 (2) Separation of functions in the supervision and utilisation of nuclear energy

Separation of functions in the supervision and utilisation of nuclear energy

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 principle of separation has also been enshrined in Article 5 (2) of Council Directive 2009/71/EURATOM and amending Directive 2009/71/EURATOM of 25 July 2014 establishing a Community framework for the nuclear safety of nuclear installations.

Realisation in Germany

The nuclear licensing and supervisory authorities of the Federation and the *Länder* are administrative state authorities. The GG requires them to act according to law and justice (Article 20 para. 3 GG). In this respect, emphasis is laid on the obligation pursuant to the AtG to take the necessary precautions against damage resulting from the construction 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 nuclear licensing and supervisory authorities on *Länder* level and the powers of supervision 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 bodies competent for the area of nuclear licensing and supervision from other bodies which, as part of the overall energy policy or energy industry promotion, also deal with matters of nuclear energy is ensured by the fact that different ministries (the BMWi as the leader in the energy sector and the BMBF for basic research) are in charge of and responsible for functions at the federal level, and different and independent organisational units are in charge of and responsible for tasks within a ministry at the *Land* level.

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

The right of the Federation derived from Articles 85 para. 3 and 87c GG to give instructions to the *Länder* executing the AtG concerning issues related to the licensing and supervision of nuclear installations lies within the competence of the BMUB. The BMUB does not fulfil any functions relating to the use and promotion of nuclear energy.

The BMUB pursues the development of new safety solutions to derive important knowledge concerning the safety of German nuclear installations in operation.

In contrast to the above-mentioned government authorities of the Federation and the *Länder*, the licence holders of nuclear installations, in their function as users and maybe 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 shareholders are also commercial enterprises under civil law, usually joint-stock companies (→ Article 11 (1)) and have no influence on the safety-directed action of the nuclear licensing and supervisory authorities.

Reporting of the regulatory body

Once a year, the BMUB shall report to the German *Bundestag* and the *Bundesrat* on the development of environmental radioactivity in the environment, as stipulated in § 5 para. 2 StrVG.

The BMUB informs the Committee on the Environment, Nature Conservation, Building and Nuclear Safety of the German *Bundestag* quarterly in the form of an overview list on reportable events in installations for the fission of nuclear fuel in the Federal Republic of Germany, i.e. nuclear power plants and research reactors with a continuous thermal power above 50 kW. In addition to the list, the BMUB informs about the publication of detailed monthly and annual reports on reportable events in German nuclear installations and research reactors through the BfS on the BfS web pages.

Challenge 4: Transparency of the nuclear licensing and supervisory authorities

For 2016 it is intended to provide an online information portal of the Federation and the *Länder* on safety in nuclear technology and thus make it available to the general public. This information portal is being developed jointly by the BMUB, the BfS and the competent nuclear licensing and supervisory authorities of the *Länder*.

So far, the BMUB, the BfS and the competent nuclear licensing and supervisory authorities of the *Länder* mainly used their own websites for fulfilling their obligations to provide information. In order to allow citizens easier access to this information, the new portal is to provide an opportunity to make relevant information available on the Internet via a central website.

In addition to information on nuclear installations in Germany and on emergency preparedness and response, it is intended to prepare and provide other relevant information via the joint online portal. This includes an overview of the regulatory system in Germany, European and international activities of the German nuclear licensing and supervisory authorities as well as basic knowledge of nuclear technology.

The overall responsibility for informing the general public in a transparent manner lies with the authorities of the *Länder*. In addition to the public participation in the licensing procedure as required by law, comprehensive information is provided on the Internet and through press releases. Inquiries on nuclear issues are answered in writing. Moreover, some *Länder* with nuclear installations established special independent commissions at the respective sites at the request of the citizens. These commissions are to inform the local public actively in regular sessions on safety issues or details of nuclear installations.

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 and the supplementing Council Directive 2014/87/EURATOM of 25 July 2014, Member States shall ensure that the prime responsibility for the nuclear safety of a nuclear installation rests with the licence holder. This is fulfilled by the provisions of the AtG regarding licensing and supervision, which are based on the principle of the licence holder’s responsibility.

According to § 7 para. 2 AtG, a licence for construction and operation may only be granted if the applicant proves that the necessary technical and organisational precautions for safe operation have been taken.

Further, § 7 para. 2 AtG stipulates that the licence for construction and operation of a nuclear installation may only be granted if there are no doubts as to the trustworthiness of the applicant and the persons responsible. Furthermore, these persons must have the necessary technical qualification.

In terms of the Radiation Protection Ordinance, the holder of the licence for a nuclear installation is also the “radiation protection supervisor” (§ 31 StrlSchV). In the case of corporate enterprises, the tasks of the radiation protection supervisor are fulfilled by a person authorised to represent the licence holder. Status and duties of the radiation protection supervisor are specified in §§ 32 and 33 StrlSchV. One of the duties of the radiation protection supervisor is to take 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. To do so, appropriate rooms, equipment and hardware have to be provided. Furthermore, the radiation protection supervisor has to prepare adequate operating procedures and ensure that sufficient numbers of qualified personnel are available.

The radiation protection supervisor appoints an appropriate number of radiation protection commissioners for the control and surveillance of the above practices to ensure radiation protection during the operation of the nuclear installation. The radiation protection supervisor shall also remain responsible if he has appointed radiation protection commissioners.

Furthermore, the AtSMV requires the appointment of a nuclear safety officer. The rights and obligations of the nuclear safety officer are specified in § 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 examination of the correctness and completeness of reports of reportable events (→ Article 19 (vi and vii)).

With the introduction of § 7c AtG (2011), the licence holder also became legally required to introduce a management system giving due priority to safety. (→ Article 10). In the non-mandatory guidance instruments, the “Safety Requirements for Nuclear Power Plants” contain fundamental organisational requirements for the management of the corporate enterprise operating, amongst others, the nuclear installation for electricity production as well as for the management of the installation itself. This also includes the integrated management system (IMS), in which all safety-related objectives and requirements have to be considered, and it contains the task given to the licence holder to maintain a highly developed safety culture and to continually improve the latter.

KTA safety standard 1402 contains the requirements for the IMS that are relevant for the guarantee and continual improvement of safety – even if different objectives and requirements are pursued – and mentions further safety-related KTA safety standards that are of importance with regard to partial aspects of the requirements for the responsible personnel (→ Article 10).

Further requirements for the responsible personnel are laid down in the guideline for the demonstration of the technical qualification of nuclear power plant personnel [3-2].

According to this guideline, 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 nuclear law and nuclear licence permits as well as for the cooperation of all departments. He is authorised to give orders to the heads of departments or sections.

The heads of departments or sections are authorised to give orders to their subordinate personnel.

The person responsible for stand-by service assumes the function of the plant manager if the latter and his deputy are not present.

The task of the responsible shift personnel (shift supervisors, their deputies and reactor operators) is to operate the nuclear installation in accordance with the written operating instructions and with the prescribed operating schedule during normal operation of the installation and to take appropriate action in the event of an accident.

When using external personnel, the licence holder has to make sure that the necessary knowledge according to the “guideline relating to the assurance of the necessary knowledge of the persons otherwise engaged in the operation of nuclear power plants” [3-27] is ensured, if necessary by persons supporting the external personnel. This also applies to the case that knowledge is communicated by the contractor. This is to be demonstrated to the nuclear licensing and supervisory authority upon request.

Implementation and measures by the licence holders

All licence holders have committed themselves in fundamental documents, such as management principles or corporate policies, to giving priority to the safety of the nuclear installations over all other business objectives. Requirements for the management systems are formulated in the “Safety Requirements for Nuclear Power Plants” and put in concrete terms in KTA safety standard 1402. Examples of such company-specific objectives are the following:

- The safety of the nuclear installations has top priority. It is based on proven technology, adequate organisational (administrative) specifications, and qualified personnel.
- Safety-relevant processes are critically questioned, monitored, and developed further.
- All actions/activities/measures are characterised by the necessary safety awareness (high significance of safety culture)
- The technical safety level reached and the condition of the installation in compliance with the requirements of the licence are maintained and further developed by means of adequate monitoring and maintenance concepts as well as by plant modifications.
- The prompt and comprehensive exchange of experiences on safety-relevant events or findings is of great importance for the German nuclear installations.

KTA safety standard 1402 says furthermore that the IMS is in the first place an instrument for the licence holder helping him to fulfil his obligations regarding the responsibility for the safety of the installation at all management levels.

The licence holder has to demonstrate to the competent nuclear licensing and supervisory authority that the requirements resulting from the guideline for the demonstration of the technical qualification of nuclear power plant personnel for the technical qualification of the responsible power plant personnel are fulfilled.

The licence holders of the German nuclear installations are members of VGB PowerTech e.V. (VGB), the European technical specialist association for electricity and heat generation. VGB is an association of companies for which the operation of power plants and the associated technology represents an important basis for their entrepreneurial action. Under the umbrella of the VGB, joint research and development in the area of “nuclear power plants” is conducted and promoted. VGB usually also organises the development of concepts, activities, and the development of the state of the art in science and technology as well as the exchange of experiences among operators.

Acting upon their responsibility, the licence holders have set themselves the task of informing the general public by means of transparent and open communication. This includes e.g.

- media relations,
- external communication of reportable events,
- crisis communication,
- external communication of power-plant-specific issues (operation, overall maintenance and refuelling outages, maintenance and modernisation projects), within the bounds of possibility,
- local public relations, e.g. discussion rounds held at the power plant site.

Regulatory review

For the German nuclear power plants, the organisation charts, the persons responsible and their area of responsibility are documented in the plant personnel organisation (Personelle Betriebsorganisation – PBO). The PBO is part of the safety specification (→ Article 19 (ii)) and a licensing document. During the licensing procedure for the nuclear installation, the regulatory authority checks whether the responsibilities are specified in an appropriate manner. The operator of the installation informs the licensing and supervisory authority of any changes in the organisation chart or of persons responsible. Any changes in the plant personnel organisation are either subject to licensing by the licensing authority or to the approval of the supervisory authority. Documents such as the operating manual (Betriebshandbuch – BHB), the emergency manual (Notfallhandbuch – NHB) or the accident mitigation manual (Handbuch für mitigative Notfallmaßnahmen – HMN) are examined either by the authorised expert or assessed by the authority itself.

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

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

The licensing and supervisory authority holds meetings with the board members or directors of the licence holder to check how the persons responsible on the part of the licence holders fulfil their obligations regarding the responsibility for nuclear safety. Here, general questions relating to safety and to the relationship between nuclear licensing and supervisory authority and licence holder may be brought up for discussion, with the nuclear licensing and supervisory authority paying heed to ensuring that the licence holder’s prime responsibility for safe operation is not impaired.

Taken as a whole, all supervisory activities of the nuclear licensing and supervisory authority are independent reviews of whether and to what extent the licence holder fulfils his obligation regarding his responsibility for the nuclear safety of the installation.

The regulatory activities in this context comprise:

A Check of the condition of the installation and its function

a. In-service inspections

b. Inspection of modifications and repairs as well as of subsequent cores

c. Accompanying inspections of modifications and repairs as well as of follow-up cores

B Check of the installation's operating behaviour

a. Evaluation of operating results and measured values

b. Evaluation of accidents and special events

c. Monitoring of the surroundings of the installation

C Check of the operator’s behaviour

a. Review of the organisation of the installation

b. Review of the technical qualification and trustworthiness

c. Review of operational management

d. Review of the operator’s (licence holder's) emergency preparedness planning

D Other activities

a. Fulfilment of requirements

b. Management of experts / Project management

c. Annual reporting

From such an integrated regulatory assessment, requirements are also derived for human and technical resources needed to be able to provide an effective on-site management for accident control or for taking action to attenuate accident consequences.

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

Priority to safety is laid down in § 1 subpara. 2 AtG. There, it is defined as a principle of the AtG to protect life, health and real assets against the hazards of nuclear energy and the harmful effects of ionising radiation. Furthermore, § 7c para. 1 AtG stipulates that the responsibility for nuclear safety shall fall to the holder of the licence of the nuclear installation and that this responsibility cannot be delegated. Accordingly, § 7c para. 2, subpara 1 AtG requires that the licence holder shall install and apply a management system giving due priority to nuclear safety.

In addition to the AtG, the StrlSchV is also to be applied for German nuclear installations. In § 33 StrlSchV it is stipulated that it is a primary duty of the radiation protection supervisor to assure protection of man and the environment against detrimental effects of ionising radiation.

In the “Safety Requirements for Nuclear Power Plants”, priority to safety is further specified as follows:

- The licensee shall give priority to safety over all other business objectives.
- The prime objectives of the IMS are specified as:
  - the guarantee of safety,
  - the continual improvement of safety, and
  - the promotion of safety culture.
- In addition, the term of safety culture, being essential in the context of giving priority to safety, is clearly defined: “Safety culture is determined by a safety-oriented attitude, responsibility and conduct of all staff required for ensuring the safety of the plant. For this purpose, safety culture comprises the assembly of characteristics and attitudes in a company and of individuals which establishes that, as an overriding priority, nuclear safety receives the attention required by their significance. Safety culture concerns both the organisation and the individual.”

The IMS is seen as a fundamental tool to ensure, continuously improve and prioritise safety. Within the national nuclear regulations, the requirements for the IMS are further specified in nuclear safety standard KTA 1402. Both the “Safety Requirements for Nuclear Power Plants” and KTA 1402 require applying the integrative approach for the management system to prevent conflicts of objectives between other business objectives and safety and thus to give due priority to nuclear safety. Here, priority to safety is implicitly required as part of the company policy. The implementation of the process-oriented and integrated management system described in the KTA safety standard ensures the necessary procedures to achieve this business objective. It also serves to strengthen safety culture and the continuous self-monitoring and evaluation of all processes. This is implemented through the so-called Plan-Do-Check-Act cycle. Furthermore, safety standard KTA 1402 specifies requirements for safe operation, organisation at different levels, monitoring, analysis, assessment and improvement as well as for the tracking of improvement measures as part of the IMS.

Implementation and measures by the licence holders

All German licence holders have committed themselves in management principles or corporate policies to giving priority to the safety of the nuclear installations over all other business objectives

(→ Article 9). To implement these principles, both the respective management system has been introduced and measures for the safety-directed behaviour of the personnel have continuously been further developed.

Before publication of nuclear safety standard KTA 1402 in 2012, already in 2008, the German licence holders of nuclear installations presented the VGB guideline “VGB-Leitfaden zum Sicherheitsmanagement”. This guideline had been based on the concept for the optimisation of the safety management system (“Konzept zur Optimierung des Sicherheitsmanagementsystems” (SMS)) (1999/2002) and describes

- the improvement of the safety level in the German nuclear installations,
- the principles and objectives of a safety management system (SMS), and
- the requirements for an SMS to ensure a high level of safety.

The VGB guideline was introduced in the process of drawing up nuclear safety standard KTA 1402 by representatives of the licence holders. The safety culture assessment system of the VGB (VGB-SBS) is an instrument for self-assessment applied by the licence holder and an element to strengthen and monitor safety culture. It also serves, according to the users, to review the effectiveness of the management system. The nuclear licensing and supervisory authorities are informed about the performance and main results of the VGB-SBS.

Regulatory review

Within the framework of licensing of a nuclear installation and within the framework of supervision of its operation, the nuclear licensing and supervisory authority regularly checks the licence holders for compliance with the legal requirements which must give priority to the safety of the installation. This includes provisions by the licence holders in order to fulfil their responsibility for the safe operation of the nuclear installations and to give priority to safety.

Through discussions with the management personnel of the licence holder, the nuclear licensing and supervisory authority verifies whether priority is given to the safe operation of the nuclear installations also at the strategic level. In this respect, the statements and the behaviour of the managing personnel of the licence holders are of particular importance. The competent nuclear licensing and supervisory authorities of the *Länder* obtain information about the safety-directed behaviour of the operating personnel of the licence holders e.g. by extensive controls during on-site inspections and from the evaluation of reportable events and other occurrences (→ Article 19).

The competent nuclear licensing and supervisory authority of the *Land* ensures that the licence holders apply the IMS and check, in particular, whether and how priority to safety is anchored in the basic principles of the management system. Some nuclear licensing and supervisory authorities of the *Länder* also review the effectiveness of the management system. In addition to the basic principles, the focus is on those processes where the priority of safety is particularly clear. These are e.g. business objectives or the management review. It is checked, for example, whether

- a selected process and the interfaces considered are described and whether this description is based on a systematic approach,
- the internal and external requirements which are to be placed on processes are met,
- processes and activities, as described in the process documentation, are performed and maintained in compliance with the regulations, and whether
- an effective review of the process under consideration is performed by the licence holder.

In addition, some of the nuclear licensing and supervisory authorities of the *Länder* use indicators to verify the safe operation of the installations (safety performance) of the licence holder and to align their activities accordingly. These safety performance indicators are partly established by the licence holder or by authorised experts and reported to the competent nuclear licensing and supervisory authorities of the *Länder*. The other part of the indicators is established by these themselves. Examples of the areas in which the indicators are surveyed are event reports, false alarms, simulations, IMS, qualifications, results of inspections and in-service inspections, activity releases and non-nuclear accidents/incidents.

Depending on the *Land*, other assessment criteria may also be considered in the assessment of the licence holder's safety management. So, for example, the nuclear supervisory authority of the *Land* of Baden-Württemberg currently uses 42 safety performance indicators and the assessment system "KOMFORT" (catalogue for recording organisational and human factors during on-site inspections). In recent years, these have been further verified with regard to their validity and use for nuclear supervision, the quality of data acquisition, and the frequency of acquisition and evaluation. The evaluations of these and other indicators are discussed with the licence holder together with other findings from nuclear supervision. The results are used for assessing the safety management of the licence holder of nuclear installations. Here, observations made and impressions gained independently of the actual inspections and which are related to safety culture are systematically collected and evaluated. Taken together, all these provide an opportunity to identify certain tendencies in the nuclear installation which could adversely affect safety and which would not have arisen from individual considerations, observations and impressions.

In general, the use of such indicators serves as an early warning system for the change of factors that could, directly or indirectly, have adverse effects on the safety of the installation. 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 the changes in meetings with the licence holders or by detailed analyses.

Internal measures of the nuclear licensing and supervisory authority for giving priority to safety

Giving priority to safety is one of the basic principles for the work of the nuclear licensing and supervisory authorities of the Federation and the *Länder*. This principle is implemented in the definition of tasks of the nuclear licensing and supervisory authorities, and it is concretised in supervisory practice. The nuclear licensing and supervisory authorities and their staff are bound by the legal provisions on licensing and operation of nuclear installations. Accordingly, the protection of man and the environment and thus the safety of a nuclear installation must be given top priority in all operations and measures. This also applies to the processes within the nuclear licensing and supervisory authorities of the Federation and the *Länder*.

Moreover, the nuclear licensing and supervisory authorities of the Federation and the *Länder* base their actions on self-defined guiding principles or mission statements, which further concretise the principle of giving priority to safety. The prime objective of the nuclear licensing and supervisory authorities of the Federation and the *Länder* is the continuous improvement of the safety of nuclear installations and the permanent and continuous supervision and monitoring of safety. The use of internal resources and the scope of support by authorised experts are oriented towards the safety significance of the tasks and issues to be clarified.

Progress since 2014

Based on the results of the IRRS Mission 2008 and the IRRS Follow-up Mission 2011, the LAA discussed the relationship between the Federation and the *Länder* (→ Article 8). The supervision of nuclear installations in Germany and the relationship between the nuclear licensing and supervisory authorities of the Federation and the *Länder* has been described by the BMUB and the competent nuclear licensing and supervisory authorities of the *Länder* in a common supervision manual ("Handbuch über die Zusammenarbeit zwischen Bund und Ländern im Atomrecht"), which is currently available in a final draft form and is expected to be adopted in 2016.

11 Financial 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 resources – legal and regulatory requirements

According to § 7 para. 2 AtG, a licence may only be granted if, among others, “there are no known facts giving rise to doubts as to the reliability of the applicant and of the persons responsible for the erection and management of the installation and the supervision of its operation” and “the necessary precautions have been taken in the light of the state-of-the-art of science and technology to prevent damage resulting from the erection and operation of the installation.”

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 damages are also criteria for supervision during operation (→ Article 7 (2iii)). According to § 17 AtG, 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 § 7c AtG, the responsibility for nuclear safety shall fall to the holder of the licence of the nuclear installation. Furthermore, according to § 7c para. 2, subpara. 2 AtG, the licence holder shall be obliged to schedule and keep ready permanent financial and human resources to fulfil his obligation regarding the safety of the particular nuclear installation.

According to § 33 para. 1 StrlSchV, a duty of the radiation protection supervisor is 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. laid down in licences, are observed. Thus, the requirement of providing the necessary financial means for operation and the post-operational phase is implicitly derived from the duties of the radiation protection supervisor (→ Article 9).

In order to be prepared for the follow-up costs connected with the operation of a nuclear installation, the licence holders are obliged pursuant to commercial law to build up financial reserves during the operating life for the decommissioning of the installations and for the management and disposal of radioactive waste, including spent fuel. In order to cover the expenditures necessary for the exploration and construction of facilities for the disposal of radioactive waste, the BfS collects advance payments for contributions for the exploration and construction to be finally paid according to the Waste Disposal Advance Payments Ordinance (EndlagerVlV).

The non-detrimental utilisation of radioactive residues and of disassembled or dismantled radioactive components or their direct disposal as radioactive waste is regulated in § 9a AtG.

Arrangements to ensure that financial resources are available in case of a nuclear event caused by a nuclear installation (liability rules) are regulated in §§ 25 to 40 AtG in addition to the provisions of the “Paris Convention” [1E-5.1]. § 38 AtG regulates the compensation for damage from the Federation (Federal Republic of Germany) for cases where the provisions of the Paris Convention and other relevant international agreements do not apply.

Implementation by the licence holders

Within the framework of management principles and corporate policies for obtaining a high level of safety, the licence holders committed themselves to maintain a high safety level, to perform appropriate backfitting measures and to provide sufficient financial resources.

To cover the follow-up costs of the operation of the nuclear installations, the licence holder continuously build up financial reserves for the decommissioning of the installations as well as for the management and disposal of radioactive waste, including spent fuel.

§ 14 AtG regulates the third party liability insurance and other forms of financial security of the licence holder in connection with the "Paris Convention" and establishes a legal connection to claims in case of damage according to the "*Insurance Contract Act*"[29].

Regulatory review

§ 13 AtG stipulates that in the licensing procedure, type, terms and amount of the financial security shall be determined that is to be provided by the applicant to meet the legal liability to pay compensation for damages (financial security). Such determination shall be renewed every two years and in the event of a material change in circumstances and conditions.

The change of the licence holder of an installation subject to licensing, e.g. in case of sale of the nuclear installation to another company, requires licensing pursuant to § 7 AtG. Changes in the legal form of the company subject to licensing also include those that may have an influence on the financial resources of the licence holder.

The operation of a nuclear installation is subject to permanent nuclear supervision. Should it turn out that safety-related investments are not made, the nuclear licensing or supervisory authority may order measures up to the revocation of the licence (§ 17 para. 5 AtG).

11 (2) Human resources and personnel qualification

To ensure safety at the German nuclear installations, § 7c AtG requires the licence holders to provide appropriate human resources. Furthermore, they have to provide for the education and further training of staff with tasks in the field of nuclear safety. The required qualification of the staff is specified in various guidelines. These are listed and explained below:

- Guideline concerning the proof of the technical qualification of nuclear power plant personnel: This guideline lays down the necessary requirements with regard to training and knowledge for the responsible plant personnel, consisting of the plant manager, the heads of department or section, the persons responsible for stand-by service, the training managers, the head of quality assurance and the nuclear safety officer as well as their deputies. The necessary requirements are also laid down for the responsible shift personnel, consisting of shift supervisor, shift supervisor deputy and reactor operator. Furthermore, for this group of staff, basic requirements apply for the examination of the technical qualification. These are specified in the guideline relating to the contents of the examination of the technical qualification of the responsible shift

29 Insurance Contract Act of 23 November 2007 (Federal Law Gazette I p. 2631), as last amended by Article 15 of the Act of 19 February 2016 (Federal Law Gazette I p. 254)

personnel [3-39]. In 2013, this guideline was supplemented by the adaptation of the rules and regulations on the qualification of responsible nuclear power plant personnel at nuclear power plants without authorisation for power operation.

- Guideline relating to the assurance of the necessary knowledge of persons otherwise engaged in the operation of nuclear power plants: In addition to the guideline concerning the proof of the technical qualification of nuclear power plant personnel, this one applies to the group of staff who has to carry out instructions and decisions of the responsible personnel. This also applies to external personnel, for which the necessary knowledge, requirements on education and introduction are regulated in this guideline. Furthermore, this guideline describes in which way the proof of knowledge is to be provided and what exceptions are included.
- Guideline for the maintenance of technical qualification of responsible nuclear power plant personnel [3-38]: This guideline lays down the requirements for the programmes for the maintenance of the technical qualification of responsible shift personnel and the requirements for the measures to maintain the technical qualification of responsible staff.
- Guideline relating to the contents of the examination of the technical qualification of the responsible shift personnel [3-39]: This guideline lays down the content of the examination of technical qualification of the responsible staff and the responsible shift personnel in detail. The technical qualification examination consists of an oral and a written part and covers both nuclear basic knowledge as well as plant-specific knowledge.
- Guideline relating to the necessary technical qualification in the field of radiation protection (guideline for the technical qualification according to the Radiation Protection Ordinance) [3-40]: This guideline lays down the requirements relating to the technical qualification of radiation protection supervisor or radiation protection officer. These include the scope of the technical qualification, the acquisition and certification of the technical qualification, and the recognition of courses and further qualification measures.
- Guideline relating to the technical qualification of radiation protection officers at installations for the fission of nuclear fuel [3-61]: Here, the requirements laid down in the guideline for the technical qualification according to the Radiation Protection Ordinance (StrlSchV) are supplemented for the radiation protection officers in nuclear installations. This applies to the scope of the technical qualification as well as to the acquisition and certification of the technical qualification.

Responsible staff

Based on the guideline concerning the proof of the technical qualification of nuclear power plant personnel, the responsible staff receive the necessary knowledge for the safe operation of the nuclear installation as part of education and training. In addition to the other persons of the responsible staff defined in this guideline, the group of the responsible shift personnel is to be mentioned in particular which is composed of the shift supervisor, the deputy shift supervisor and the reactor operator. The necessary qualifications that must be proven comprise the following:

- For shift supervisors:
  Degree in mathematics, sciences or technology in the relevant discipline.
  For shift supervisor deputies:
  At least a completed vocational training as technician or a master's certificate in the relevant discipline,
  For reactor operators:
  completed vocational training as technician or a master's certificate, at least, however, a journeyman's certificate or a completed vocational training as a certified power plant operator in the field of nuclear technology,
- the necessary basic knowledge in physics, technology and law,

- the necessary knowledge concerning the design and behaviour of the installation as well as emergency preparedness measures and relevant standards and guidelines,
- the ability to operate the installation safely also in the event of incidents and accidents (for the reactor operator: safe operation of the installation from the control room or the supplementary control room),
- at least three years of practical experience in the installation (two years for reactor operators), including at least six months as a reactor operator (not applicable to reactor operators, instead of it six months of practical experience in the shift operation of the nuclear installation), and
- a simulator training course of seven weeks (BWR) or eight weeks (PWR).

Following the training it is ensured by examining the qualification that the knowledge acquired meets the requirements.

Through various measures as part of technical qualification maintenance it is ensured that the skills and knowledge of responsible shift personnel is maintained also beyond the initial training phase. This includes, among other things, theoretical and practical retraining, simulator courses and seminars. When planning these measures, new findings and changed or additional requirements are always to be taken into account. The operating experience, both from the own installation and, as far as applicable, from other nuclear installations, is also to be dealt with. Proof of the performance of these measures is to be supplied to the nuclear licensing and supervisory authority on an annual basis.

Other staff

The requirements defined in the guideline relating to the assurance of the necessary knowledge of persons otherwise engaged in the operation of nuclear power plants are based on the assignment to knowledge groups and knowledge levels, depending on the field of activities. These are divided into four knowledge groups (radiation protection, fire protection, industrial safety and plant organisational structures and procedures), each with three knowledge levels. Based on the field of activity, each person working in the power plant is assigned to a corresponding level in all four groups. By means of training courses, the licence holder has to ensure that the persons receive the relevant skills and knowledge. For external personnel, these requirements may be less stringent if they will have a supervisor during their work. Checking the external personnel is the responsibility of the licence holder (→ Article 13).

Simulators

Plant-specific full-scope simulators are available for German nuclear installations with authorisation for power operation at the Kraftwerksschule Essen. Simulator training is an essential part of the acquisition and maintenance of technical qualification. Training is regularly adapted to new findings and technical facts. The training courses deal, among others, also with methods for coping with stress situations and communication. Particular attention is paid to the feedback of operating experience.

The simulators reproduce the referenced nuclear installation in appearance and also in its technical, physical and temporal behaviour. The operating staff encounter the same working conditions and requirements as they would or could occur when operating and monitoring the real installation.

The training programmes cover the entire operating range of the nuclear installation: normal operation, operational disturbances as well as all incidents and accidents in any combination and under various boundary conditions. Training places equal emphasis on operating and understanding the technology as well as on human performance in the team.

Knowledge maintenance

Also in view of the remaining operating lives of the nuclear installations until 2022 it is still necessary to maintain the acquired specialist knowledge and to further develop the state of the art in science and technology in order to continue to maintain and improve the current level of safety of the nuclear installations. For this purpose, maintenance of competence in nuclear technology is ensured in particular through the project-based funding of research projects in the field of nuclear safety and waste management research of the BMWi. The Federal Ministry of Education and Research supports projects in nuclear safety and waste management research for the promotion of young scientists and maintenance of competence.

Supervision

As part of the licensing and supervisory procedure, the competent nuclear licensing and supervisory authority has to verify compliance with all guidelines listed in this article. This is done on the basis of regular proofs to be furnished by the licence holder. Within the framework of the technical qualification examinations, this is ensured by the participation of a representative of the nuclear licensing and supervisory authority in the examination board as assessor. Through discussions with the licence holder and controls in the installation, individual aspects of recruitment, personnel development and staffing are assessed and evaluated. Furthermore, the licence holder submits proofs of training of the responsible staff and his three-year programme on the maintenance of technical qualification of the responsible shift personnel to the competent nuclear licensing and supervisory authority of the *Land*. In addition, a significant change in the number of staff employed also requires review and approval by the competent nuclear licensing and supervisory authority of the *Land*.

Challenge 6: Monitoring of the personnel situation in the nuclear installations

In 2012, the RSK published a memorandum on the potential threat to nuclear safety by loss of know-how and motivation[30]).

In its memorandum, the RSK states that competent and motivated staff will continue to be required both for the remaining operating lives of nuclear installations as well as for their decommissioning and for radioactive waste management and storage. Due to the limited career prospects, the RSK is of the opinion that there is a potential threat as regards the factor “motivation”. Therefore, the RSK considers it necessary “(...) that the work of these employees is respected and recognised by the company management, politics and the media according to the responsibility borne by these employees. A general defamation of people working in the nuclear sector will impair the motivation of the employees and will thus be detrimental to safety.” The RSK has concerns about whether the knowledge required for safe operation of the nuclear installations can be maintained at the necessary level in case of a further negative development and the resulting decreasing motivation of the employees.

Based on the memorandum of July 2012, the BMUB asked the RSK to submit further proposals for measures to avoid a loss of know-how and motivation among employees in nuclear technology.

All licence holders have taken appropriate internal measures. Other companies and organisations of the nuclear industry draw, on the whole, a positive conclusion and stress that they meet all the conditions to ensure nuclear safety for the operation of the installations in Germany until the end of operation and, where necessary, even beyond it despite the reduced order volume in Germany (which partially decreased by 1/3) and the reduction of nuclear staff, which mostly has already tak-

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30 RSK Memorandum, “Potential threat to nuclear safety by loss of know-how and motivation”, adpoted at the 449th RSK meeting on 12 July 2012, www.rskonline.de/sites/default/files/German/downloads/epanlagersk449homepage.pdf

en place and is still required. According to the reporting in the RSK, a specific problem has occurred in none of the institutions concerned so far.

The RSK currently discusses whether the implementation and review of suitable measures for the maintenance of motivation should be recommended, since a loss of motivation, in addition to a loss of know-how that may result from staff departure, can also adversely affect the safety-directed action of the staff. Another topic of discussion is also the compilation of indicators in order to identify a loss of motivation at an early stage and to be able to take countermeasures. The discussions of the RSK are expected to be concluded in 2016 with the drafting of appropriate recommendations.

Within the framework of its competence, the nuclear supervisory authorities of the *Länder* also supervise the assurance of the necessary knowledge of the responsible staff and persons otherwise engaged in the nuclear installations (→ Article 12). Since the 13th AtG amendment, increased attention is also paid to the measures taken by the licence holders to prevent a loss of motivation and know-how in nuclear supervisory procedures of the *Länder*.

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

According to § 7 para. 2, subpara. 1 AtG, a licence to operate a nuclear installation may only be granted if there are no doubts about the trustworthiness of the persons responsible and if these have the requisite technical qualification.

The non-mandatory guidance instrument “Safety Requirements for Nuclear Power Plants” stipulates that the licence holder of a nuclear installation has to ensure the development, introduction and continual improvement of an integrated process-oriented management system. Furthermore, operating principles have to be realised to promote safety. Among these general requirements are i.a.

- maintenance- and inspection-friendly design of the systems and plant components, with special consideration of the radiation exposure of the personnel,
- ergonomic design of the workplaces,
- reliable monitoring of the operating conditions that are relevant to the respective operating phase.

In addition, the “Safety Requirements for Nuclear Power Plants” make ergonomic requirements and demand their consideration in the design of measures and activities as a prerequisite for the necessary safety-related and reliable acting of the personnel.

These requirements are specified i.a. by the following KTA safety standards:

- KTA safety standards 1201 “Requirements for the Operating Manual”, 1202 “Requirements for the Testing Manual” and 1203 “Requirements for the Emergency Manual” contain the requirements for the respective manuals (→ Article 19). These also comprise the requirements for the ergonomic representation of information, especially if the latter is not available on paper.
- KTA safety standard 1301.1 “Radiation Protection Considerations for Plant Personnel in the Design and Operation of Nuclear Power Plants” deals in general with the protection of the workers against ionising radiation (→ Article 15) during operation. This also includes the consideration of ergonomic aspects to keep working times as short as possible.
- KTA safety standard 1402 “Integrated Management Systems for the Safe Operation of Nuclear Power Plants” defines in detail the components of an integrated management system (IMS) (→ Article 11), requiring i.a. that all activities with an indirect or direct influence on the safe operation of a nuclear installation be detected, described, coordinated and continually reviewed and improved.
- KTA safety standard 3501 “Reactor Protection System and Monitoring Equipment of the Safety System” describes the requirement for the safety system that human factors are also to be considered in connection with accident control. Section 4.1.10 (2) stipulates e.g.: “Failure due to errors and negligence in connection with necessary manual actions for the operation and maintenance of A-Function installations shall be prevented (…) and measures to limit the consequences of failures shall be considered. (…) Measures that are suitable for this purpose are e.g.: (…) a clear arrangement of the components of the safety system through ergonomic design “.

- KTA safety standard 3904 “Control Room, Remote Shutdown Station and Local Control Stations in Nuclear Power Plants” contains requirements for the control room, supplementary control room and local control stations of a nuclear installation. This concerns e.g. the design of the control room according to ergonomic aspects in order to prevent human error.

Furthermore, the RSK made two recommendations that concern the human factor in nuclear installations:

- *Requirements on the determination of the minimum shift staffing at nuclear power plants to ensure safe operational management*[31]. In order to regulate the minimum shift staffing during power operation, deliberations were made in this document on how this should be specified. It is recommended that the minimum shift staffing should be chosen such that an event on level of defence 3 can be controlled. The resulting number of staff is listed in detail.
- Guideline for the performance of integrated event analyses. This guideline contains recommendations regarding the performance of integrated event analyses as part of experience feedback. Here, it is in particular all contributing factors from the areas man, technology and organisation and their interactions which are considered. As regards content, the guideline deals with the targets and criteria of the event analysis as well as with the requirements for the analysis method and the organisation. Recommendations on the documentation of the events are also included.

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

German nuclear power plants are highly automated. This includes the automatic activation of many complex switching operations in addition to the extensive instrumentation and control for normal operation. This helps to relieve the personnel from routine actions and to focus on the monitoring of the safety-relevant processes and process parameters. The workplaces necessary for monitoring and for switching actions are, as demanded by the national nuclear regulations, designed according to ergonomic aspects. The routes to the workplaces are also laid out correspondingly.

The reactor protection system is designed such that within the first 30 minutes after the onset of an accident there is no need for any manual action. In case of any anticipated operational occurrences or design basis accidents, this concept aims to ensure sufficient time to diagnose the situation and take appropriate actions. Manual actions may still be performed by the shift personnel within the specified 30 minutes if there is an unequivocal diagnosis of the accident and if the manual actions are clearly safety-directed (e.g. if they effect a mitigation of the accident sequence). The NHB – which is applicable in beyond-design-basis accidents – is also designed with ergonomic aspects in view. Its structure has been chosen such that it is still possible to carry out the prescribed measures even under the special conditions of the emergency situation.

Computerised information systems support the shift personnel in all nuclear installations. 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 actuation by the reactor protection system in the course of an in-service inspection.

To protect the operating personnel from ionising radiation, corresponding radiation protection measures are provided in all nuclear installations. These also consider ergonomic aspects so that working times during maintenance are kept as short as possible and that consequently radiation

31 RSK recommendation, “Requirements on the determination of the minimum shift staffing at nuclear power plants to ensure safe operational management”, adopted at the 417th RSK meeting on 18 Juni 2009

exposure is kept as low as possible. One of these measures is also the quick and correct registration of the actual state of the installation and the systems.

Implementation and measures by the licence holders

The licence holders of nuclear installations apply comprehensive measures to avoid failures that are down to human actions or organisational shortcomings. This includes not only the prevention of negative effects of failures through suitable measures (defence in depth) but also the early detection of potential failures before they can occur, their analysis, and the elimination of the causes of such potential failures through improvement measures to exclude a recurrence of the same failure in the future.

Here, the most important measure is the feedback of experience from internal and external operating experience. This is organised within the framework of the IMS (→ Article 13) is characterised by a systematic exchange of experience with regard to safety-relevant information and events. In order to be able to put a systematic exchange of experience into practice, special emphasis is laid on ensuring that communication is good between all levels of the operating organisation. To draw additional profit from the external experiences, the licence holders of the German nuclear installations cultivate a lively exchange of experience.

The information that is gathered is evaluated as part of an integrated event analysis (→ Articles 6 and 19). The aim of this analysis is to learn from past operating experience and derive safety-related improvements. To achieve this, the areas man, technology and organisation are treated equally. The analysis also looks at weak points and failure sources at the interfaces of the three areas. This integrated examination makes it possible to identify all factors that have led to an event. On this basis, measures are subsequently derived to prevent a recurrence of the event sequence. In 2000, the licence holders began developing the VGB Guideline “Integrated event analysis”, which was first presented in 2003. Since then, it has been updated several times and adapted accordingly to new insights.

To prevent error-induced events already in advance, ergonomic aspects have already been included in the design of the operating manuals. Here, much attention was paid to easy handling and comprehensibility. The test instructions in the testing manual, too, take ergonomic aspect for the respective measures into account.

Self-assessment of management and organisation of the licence holders

The management and organisation of the licence holders of nuclear installations are based on a statutory IMS whose requirements are described in the “Safety Requirements for Nuclear Power Plants” as well as in KTA safety standard 1402 (→ Article 9). These demand i.a. continuous monitoring and assessment of all processes. Here, the fulfilment of the process targets, process performance, the adherence to the process specifications and the possibilities of improvements are used as indicators for the assessment of the processes. These assessments are performed on the one hand as part of reviews with national and international experts. On the other hand, audits and independent process assessments are also performed by management staff of the nuclear installation itself. On the basis of the information gathered, a data analysis is carried out in order to assess the effectiveness and quality of the management system. If in the course of this assessment any deviations or inadequacies are identified, corresponding improvement measures are specified.

Organisation of the feedback of experience regarding human and organisational factors

If there are any events with relevance to other installations, the operating experience derived from the analysis of such safety-relevant events is communicated via the competent nuclear licensing and supervisory authority of the *Land* to the licence holders in the form of a so-called information notice (WLN) (→ Article 19). The licence holders then prepare a feedback regarding the contents of the WLN, especially also with a view to the applicability to their own nuclear installations. Within the framework of these mechanisms, experiences regarding human and organisational factors are also passed on. These experiences are then used e.g. for training of the operating personnel as part of the preservation of their technical qualification. Should any organisational deficiencies come to light in the course of the analysis, the processes have to be optimised within the framework of the IMS.

In addition, the RSK prepares generic recommendations on the basis of experiences and findings. These are published and taken into account by the nuclear licensing and supervisory authorities of the *Länder*.

Regulatory review

The fulfilment of requirements for the man-machine interface is reviewed by the competent nuclear licensing and supervisory authority of the *Land*. This is done in the context of the granting of the nuclear licence for the construction and operation of nuclear installations according to the requirements of the national nuclear rules and regulations applicable at the time in question. For this purpose, the safety demonstrations provided by the applicants, e.g. by the licence holders, were subjected to comprehensive reviews by the competent nuclear licensing and supervisory authority. Any later modifications of safety-relevant plant components and written operating rules, e.g. the operating manual (KTA safety standard 1201) or the testing manual (KTA safety standard 1202), require licensing (or in the case of minor changes approval or acknowledgement) by the competent nuclear licensing and supervisory authority of the *Land*. Modifications are hence subject to comprehensive official review within the framework of the modification procedure. When assessing reportable and other events, the competent nuclear licensing and supervisory authority will also take contributing factors from the areas man and organisation into account.

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

According to § 7c para. 2 AtG, the licence holder shall be obliged to establish and apply a management system.

The basic requirement for systematic quality assurance at nuclear installations can be found in the "Safety Requirements for Nuclear Power Plants". There, the implementation of an IMS is required for all nuclear installations. Its objectives and requirements also include quality assurance. This is specified within the framework of the national nuclear rules and regulations, especially in the KTA safety standards, as follows:

- Nuclear safety standard KTA 1401 "General Requirements Regarding Quality Assurance":
  This safety standard explains and defines, among other things, the basic requirements for quality assurance, the organisation and planning as well as for the design. As announced in the national report for the Sixth Review Meeting, safety standard KTA 1401 has been revised and entered into force in November 2013. Among other things, the field of "operation" has been moved to safety standard KTA 1402, and it is required that a systematic quality management is also applied by the subcontractors.
- Nuclear safety standard KTA 1402 "Integrated Management System for the Safe Operation of Nuclear Power Plants":
  This safety standard includes requirements for an IMS. These requirements ensure that all safety-relevant activities and processes are identified and described in a management system. Full and complete recording and description of all work procedures and activities as interlinked processes and their recognisable dependencies facilitates reviews and assessments and enables the continuous improvement of plant safety as safety performance of the comprehensively described organisation and its functioning.

In addition, basic requirements for quality management are also included in "*DIN EN ISO 9001:2015*"[32]. This standard is applied in many sectors of the industry and is used by the licence holders to ensure the quality of products of contractors and subcontractors.

Elements of the integrated management system

The IMS defined in nuclear safety standard KTA 1402 is based on a process-oriented approach. All activities relevant for operation are to be identified and, if having a direct or indirect influence on safety, are to be described by processes. In addition, continuous review and improvement of processes and the IMS is ensured by the consistent use of the Plan-Do-Check-Act cycle. In order to be able to understand the process and the decisions taken at any time, all processes are documented in a standardised and consistent manner.

The elements of an IMS are defined in nuclear safety standard KTA 1402 and specified by detailed requirements. A key element is the responsibility of the management. Related requirements are as follows:

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32 DIN EN ISO 9001:2015-11, Quality management systems - Requirements

- Responsibility of the company management:
  The company management has the responsibility to ensure the safe operation of their plants. For this purpose, it has to implement various issues. These include the development, implementation and continuous improvement of an IMS, the definition, implementation and communication of the company policy and business objectives for a high level of safety and for a strong safety culture, the establishment of principles for the organisational and operational structure, the regular review of the effectiveness of the management system as well as naming of the plant manager.
- Responsibility of the plant management subordinate to the company management:
  This includes, among others, ensuring the safe operation of the plant, the development, introduction and continuous improvement of an integrated management system, compliance with statutory, regulatory and safety-related requirements, drawing-up and implementation of the plant policy in line with the company policy, the implementation of the organisational and operational structure within the plant according to the principles laid down by the company management, guaranteeing the necessary competences and qualification of the personnel, and the regular review of the effectiveness of the management system.
- Other requirements are related to the IMS officer, the process supervisor and the management review.

Implementation of an integrated management system

The overall objective of the IMS is, in addition to nuclear safety, to also integrate requirements from other company perspectives (e.g. economic aspects) into the management system. The IMS is to ensure that in case of competing demands and objectives for the plant, those of nuclear safety are given priority according to their significance.

Each licence holder already had to meet individual specific requirements for quality assurance on the basis of the provisions of the “Safety Criteria for Nuclear Power Plants” [3-1] from 1977. In 2012, the safety criteria were replaced by the newly developed “Safety Requirements for Nuclear Power Plants”. Here, the specific requirements for quality assurance were also supplemented by an IMS. In addition, nuclear safety standard KTA 1401 was revised and nuclear safety standard KTA 1402 newly created to provide specifications in the fields of quality management and IMS. The concrete implementation of the requirements from “Safety Requirements for Nuclear Power Plants” and the nuclear safety standards 1401 and 1402 is described in plant-specific documents. These documents further specify how and by whom the requirements necessary for safety are established and fulfilled, and how and by whom their fulfilment is verified. These include descriptions of procedures for the initiation of corrective measures in case of non-compliance with the requirements. Furthermore, the structure of the organisation implemented for quality assurance is described and reference is made to work procedures for the performance of quality assurance.

Audit programmes of the licence holder

Quality assurance is carried out by the licence holder as part of its responsibility for the safety of the plant.

With the introduction of “DIN EN ISO 9001:2000” (now “DIN EN ISO 9001:2015”) and the related discussion about management systems, e.g. the safety management system, the licence holders further developed quality assurance to a process-oriented and thus adaptive quality management. Some nuclear installations have their quality management system already certified according to “9001 DIN EN ISO”.

In exercising their responsibility for safe operation, the licence holders regularly review the effectiveness of their management systems by own internal reviews. These reviews are typically applied for management systems and for processes or products, including maintenance work.

Audit programmes of the licence holder for manufacturers and suppliers

For supplies and services, contractors and their subcontractors must plan and carry out quality assurance in accordance with the requirements of the quality system of the nuclear installation. The licence holder checks the contractors according to nuclear safety standard KTA 1401. For each subcontract, a contractor assessment is performed.

The data and information about the contractors are stored in a central database of VGB and are available for each nuclear installation. Any identified gaps and deficiencies are immediately communicated and corrective actions are taken.

Regulatory review

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

- Results of the management review
- Results of the internal audits
- Evaluation of indicators (→ Article 10)
- Implementation of measures derived
- Further development of the integrated management systems
- Promotion of safety culture (integral part of the management system)

On the basis of findings obtained, the *Land* authority competent for licensing and supervision generally verifies the effective implementation of the quality assurance system. Moreover, the supervisory authority controls the results of the reviews performed by the licence holder and the implementation of measures derived from it within the framework of on-site inspections. This also includes inspections of the production process of technical components at the manufacturers and suppliers of the licence holder. The overall organisational responsibility for an effective management system remains with the licence holder.

Ensuring product quality in the long term

The quality of the required safety-related components of the German nuclear installations is regulated by long-term supply contracts with the component manufacturers. The supply of quality-assured parts can thereby be planned over periods of several years and is supported by the close cooperation between the licence holders themselves and within the framework of the VGB activities for nuclear procurement. In addition, all licence holders have well-equipped local workshops or contracts with such workshops which can manufacture selected parts themselves or carry out repairs. Significant changes, for example regarding the range of products or in the manufacturing market, can be recognised in time by further measures and processes and alternative solutions applied. These include for example, besides the above-mentioned audit programmes and contractor assessments, targeted provision and adaptation of technical specifications and testing requirements, additional contractor training, continuous feedback of experience, suppliers market assessments, strategy discussions with manufacturers and suppliers for the provision of services and supply of spare parts until the end of the operating life, as well as an optimised management for spare, stand-by and wear parts in stockkeeping, also in connection with decommissioning.

Thus, the requirements of nuclear safety standard KTA 1401, revised in 2013, can also be fulfilled in the long term, according to which the client shall ensure, when re-ordering series-produced items, that these have not been changed with regard to the original order or, in the case of changes, a renewed qualification may be required. The prerequisites for the supply with quality-assured products have thus also been created with regard to the remaining operating lives, laid down by law, until 2022.

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 § 7 para. 2 of the AtG, a licence for major modifications of nuclear installations or their operation may only be granted if

1. there are no known facts giving rise to doubts as to the reliability of the applicant and of persons responsible for the construction and management of the installation and the supervision of its operation, and the persons responsible for the construction and management of the installation and the supervision of its operation have the requisite qualification,

2. 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,

3. 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,

4. the necessary financial security has been provided to comply with legal liability obligations to pay compensation for damage,

5. the necessary protection has been provided against disruptive action or other interference by third parties,

6. 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 following “List of Contents”), in 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], and, for specific technical aspects and occasions, in the various regulations of the non-mandatory guidance instruments such as the “Safety Requirements for Nuclear Power Plants”, their “Interpretations” and the safety standards of the KTA (→ Article 7 (2i)).

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 in detail to the competent nuclear licensing and supervisory authority that the licence prerequisites stated in § 7 para. 2 of the AtG (→ Article 7 (2ii)) are fulfilled. § 3 of the AtVfV 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. Thus, the safety analysis report is the basis for the safety assessment of the nuclear installation.

According to the “List of Contents”, 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.

The above-mentioned “List of Contents” provides a standardised form for safety analysis reports of nuclear installations with 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
- power plant and protective measures against internal and external hazards
- organisational structure and responsibilities
- radioactive materials and the corresponding physical protection measures
- power plant operation
- design basis accident analyses.

Except for the conditions and limits of safe operation and emergency preparedness, the safety analysis report thus covers all topic areas demanded by the IAEA Safety Standard GS-G-4.1. In Germany, the conditions and limits of safe operation are part of the operating manual. The emergency organisation is described in the NHB, which is required according to KTA safety standard 1203. Furthermore, information on the future decommissioning of the nuclear installation is 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.

Together with the application for the operation of the installation, the safety specifications required by the AtVfV and described in the “Guidelines Concerning the Requirements for Safety Specifications for Nuclear Power Plants” [3-4] as well as in KTA safety standard 1201 “Requirements for the Operating Manual” have to be presented. They comprise in particular details on

- the organisational structure,
- safety-relevant requirements,
- reactor protection system limit values,
- technical drawings of important components including operating parameters, preceding limits, actuating limits, and design basis values,
- the general in-service inspection plan for systems and components important to safety and
- the treatment of reportable events.

These safety specifications as well as the associated inspections of safety-relevant plant components are described in more detail in Article 19 (ii). All documents prepared or to be prepared for verification purposes, including the expert analysis reports and assessments by the licensing and supervisory authority, have to be compiled systematically in a safety documentation. The licence holder has to prepare the safety documentation on the basis of the guidelines regarding the fundamental principles and requirements and keep it up to date. The safety documentation includes all technical documents required in terms of the AtG for verifications in nuclear licensing and supervisory procedures. These include e.g.:

- documents on the provisions governing the design, construction, 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. verification calculations and design plans or drawings,
- operating records that are significant from a safety-related point of view,
- documents pertaining to the radiation protection of the personnel and the environment, and
- other documents proving the fulfilment of safety-related specifications, requirements and directives.

In compliance with the licensing prerequisites, the licence holder has to perform the safety assessments of nuclear installations with 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 § 7 of the AtG or modifications subject to approval within the framework of supervision according to § 19 of the AtG (→ Article 7 (2ii)).

The safety review required according to § 19a of the AtG is dealt with in detail further below.

Safety assessments only taking into consideration a specific section of the nuclear installation are e.g. the analyses to be performed for the safety demonstration on the new reactor core before refuelling. The 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 their 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 § 7 of the AtG or modifications subject to approval within the framework of supervision according to § 19 of the AtG. The licensing procedure for modifications pursuant to § 7 of the AtG 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)). As regards modifications of the nuclear installation or its operation that are not subject to licensing pursuant to § 7 of the AtG due the negligibility of their impact on safety, these are regulated in Germany in the different supervisory procedures of the *Länder*. These regulations specify which types of modifications require prior approval by the licensing and supervisory authority and of which modifications the licensing and supervisory authority only has to be notified.

After any safety-relevant occurrences at a nuclear installation, the licensing and supervisory authority may require safety assessments, in particular if measures against a recurrence or for an improvement of safety have to be taken. Safety assessments may also be required in case of any safety-relevant occurrences at other nuclear installations with regard to their possible applicability to the installation in question. New findings from plant operation or the latest state of the art in science and technology may require that safety demonstrations that have already been provided need to be updated.

Decennial safety review

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

The SÜ results have to be submitted to the competent licensing and supervisory authority of the *Land* and are assessed by independent experts who act by order of the licensing and supervisory authority.

Since the amendment of the AtG of April 2001, the performance of SÜs every ten years has been mandatory, with the date of the first SÜ laid down for every installation. The obligation to present the SÜ results is lifted if the licence holder makes the binding declaration to the licensing and supervisory authority that he is definitively going to terminate power operation at the installation no later than three years after the final date for submission of the SÜ mentioned in the AtG. Considering the dates for final shutdown laid down in the AtG, it follows that in future, safety reviews will only have to be performed for two nuclear installations (Gundremmingen C and Brokdorf) (→ Table 14-1).

A focal point for the deterministic safety status analysis is the consideration of the accidents compiled in Appendix A of the guideline for the safety status analysis [3-74.2] 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.

For nuclear installations in the post-operational phase, the LAA decided that the licence holder has to perform a safety analysis for this phase. Corresponding details are specified in a “Checklist for the performance of an assessment of the safety status of the installation for the post-operational phase”.

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 installations fulfil the safety requirements that are necessary for compliance with the protection goals, referred to as “fundamental safety functions” in the IAEA safety standards (→ Article 18 (i)).

Table 14-1 Safety reviews of the nuclear installations

	Installation	Type	Last date	Next date
1	Biblis A (KWB A)	PWR	31.12.2001 (31.12.2011*)	--
2	Biblis B (KWB B)	PWR	31.12.2000 (31.12.2010*)	--
3	Neckarwestheim 1 (GKN 1)	PWR	31.12.2007	--
4	Brunsbüttel (KKB)	BWR	30.06.2001 (30.06.2011*)	--
5	Isar 1 (KKI 1)	BWR	31.12.2004	--
6	Unterweser (KKU)	PWR	31.12.2001 (31.12.2011*)	--
7	Philippsburg 1 (KKP 1)	BWR	31.08.2005	--
8	Grafenrheinfeld (KKG)	PWR	31.10.2008	--
9	Krümmel (KKK)	BWR	30.06.2008	--
10	Gundremmingen B (KRB B)	BWR	31.12.2007	--
11	Grohnde (KWG)	PWR	31.12.2010	**
12	Gundremmingen C (KRB C)	BWR	31.12.2007	31.12.2017
13	Philippsburg 2 (KKP 2)	PWR	31.10.2008	**
14	Brokdorf (KBR)	PWR	31.10.2006	31.10.2016
15	Isar 2 (KKI 2)	PWR	31.12.2009	**
16	Emsland (KKE)	PWR	31.12.2009	**
17	Neckarwestheim 2 (GKN 2)	PWR	31.12.2009	**

Shaded fields denote the nuclear installations that have been shut down.
* Safety review performed, no evaluation
** No future safety review required according to § 19a para. 2 AtG
(Power operation will cease no later than three years after the ten-year review interval).

Safety assessments performed

Deterministic safety analyses

These analyses have already been dealt with in the section on the “decennial safety review”.

Probabilistic safety analyses

The mid-1970s saw an increasing use of probabilistic safety analyses in Germany in supplement to deterministic safety assessments. 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 PSA are described in technical documents (“Methods” and “Data” volumes for the probabilistic safety analysis for nuclear power plants) supplementing the “Guide Probabilistic Safety Analysis” and were first published in 1996 and updated in 2005.

Since 1990, the licence holders operating the German nuclear installations have performed Level 1 PSAs as part of the periodic safety review for all German nuclear installations. Level 2 PSAs also exist for all nuclear installations in power operation. The Level 1 PSAs in particular have led to technical and procedural improvements at the nuclear installations.

Since 2005, a Level 1 PSA has comprised

- plant-internal initiating events for all operating states (power operation and low-power and shutdown states),
- for power operation, common-cause initiators such as fire, internal flooding,
- postulated site-specific external hazards such as
  - aircraft crash,
  - blast wave,
  - flooding and
  - site-specific earthquake with an intensity of more than 6 on the MSK (Medvedev-Sponheuer-Karnik) scale.

A Level 2 PSA has to be performed for internal initiating events for power operating conditions.

The FAK PSA (Facharbeitskreis Probabilistische Sicherheitsanalyse für Kernkraftwerke) technical committee established by the BMUB and coordinated by the BfS, is a committee of experts in the field of PSA. The FAK PSA works out proposals for the updating of technical documents on PSA methods and data according to the established state of knowledge. A revision and updated version of the methods and data volume of the PSA Guide was presented to the Technical Committee for Nuclear Safety (Fachausschuss Reaktorsicherheit – FARS) of the Federal/*Länder* Committee for Nuclear Energy (LAA) for approval and resolution in 2015 and is to be adopted in 2016. It contains supplementary documents on the topic areas “Level 2 PSA”, “PSA for low-power and shutdown states”, “Consideration of the human factor in a PSA” and “PSA for external hazards”, which need to be looked at in more detail to be in line with the state of the art in science and technology.

Since according to the 13th AtG amendment only two of the nine nuclear power plants in operation have to perform probabilistic safety analyses within the framework of the required safety review, a revision of the PSA Guide is no longer planned.

Backfitting measures and improvements performed and current activities

Preventive accident management measures

Additional to the very comprehensive backfitting measures that had already been carried out after Chernobyl in the area of prevention (→ Tables 6-2 and 6-3), further preventive accident management measures were implemented during the review period in all nuclear installations in power operation. To re-establish the three-phase AC current supply in an emergency scenario, all nuclear installations acquired one or more mobile diesel generators, and suitable external connections for these generators were established. These diesel generators can furthermore be used in the beyond-design-basis range to ensure the DC power supply within the first ten hours. Accident management measures were also added or optimised in the areas of residual-heat removal from the core and from the spent fuel pool. For this purpose, mobile pumps and hose equipment were acquired to build up corresponding mobile residual-heat removal chains. The accident management measures for the spent fuel pools were extended and optimised, and cooling water sources that are independent of the primary heat sink were established.

Manual for mitigative accident management measures

The licence holders of the German nuclear installations have furthermore developed a generic concept for dealing with severe accidents, taking the form of a HMN supplementing the existing emergency manual (NHB). The strategies and procedures contained in these manuals are in line with the international recommendations regarding SAMG. This concept has in the meantime been introduced in all nuclear installations in power operation and is subject to continual improvement.

Robustness analyses for the beyond-design-basis area (cliff edge effects)

Following the Fukushima nuclear accident, the licence holders, exercising their responsibility for nuclear safety, carried out supplementary analyses of the safety precautions in their nuclear installations regarding the robustness and effectiveness of the safety functions that are vital for the prevention and limitation of radioactive releases under beyond-design-basis impacts. Due to the already existing very high level of protection of the nuclear installations, extremely unlikely scenarios had to be postulated in the robustness analyses in order to highlight safety margins to cliff edge effects in the beyond-design-basis area and to identify optimisation potentials. In summary, it was shown that cliff edge effects can generally already highly reliably be prevented with the help of the existing prevention and emergency measures. Additional robustness-increasing measures have further improved robustness in the beyond-design-basis area and the control of beyond-design-basis events as well as the limitation of their consequences. Further details are given in Appendix 6.

Regulatory review

The assessment of the safety of the nuclear installations is continuously reviewed by the competent *Land* authorities within the framework of the nuclear supervisory procedure. If there are any new safety-relevant findings, the need for the implementation of safety-related improvements is examined. This is done by reviewing documents on site at the nuclear installations.

As part of nuclear supervision, safety assessments conducted by the licence holders are reviewed both continuously and discontinuously by the nuclear licensing and supervisory authorities of the *Länder*, as are the special periodic safety reviews stipulated by §19a AtG. Results of these reviews regarding necessary safety-enhancing measures or upgrades are in most cases implemented by the licence holders on a voluntary basis. In addition, if generic aspects are concerned, federal supervision is involved.

For the review of the documents submitted by the licence holders, the competent licensing and supervisory authority may consult, in accordance with § 20 AtG, independent authorised experts for the review and assessment of specific technical aspects (→ Article 8 (1)). The general requirements for such expert evaluations are specified in the “Framework Guideline on the Preparation of Expert Opinions in Nuclear Administrative Procedures” [3-34].

The experts carry out a detailed review of the documents submitted by the applicant. Applying assessment criteria on which the review is to be based, they perform independent analyses and calculations, preferably with analytical methods and computer codes different from those used by the applicant. The results are evaluated. The persons participating in the evaluation are free in their judgement and are mentioned by name to the nuclear licensing and supervisory authority.

Challenge 1: National Action Plan

After the Fukushima nuclear accident, further actions were initiated in Germany to review the safety of German nuclear installations. As a result, the RSK derived recommendations, and GRS prepared information notice “WLN 2012/02” on behalf of the BMUB. In addition, Germany took part in the European stress test, which resulted in the implementation of further measures. In order to summarise the essential activities after Fukushima, a National Action Plan was prepared which is updated annually and published on the web pages of the BMUB.

This National Action Plan contains the plant-specific status of the measures that are either being planned or have already been implemented with regard to WLN 2012/02 and to the following RSK results:

- RSK Statement: Plant-specific safety review (RSK-SÜ) of German nuclear power plants in the light of the events in Fukushima-1 (Japan), (437th RSK meeting from 11 to 14 May 2011)
- RSK Statement: Loss of the primary ultimate heat sink (446th RSK meeting on 5 April 2012)
- RSK Recommendation: Recommendations of the RSK on the robustness of the German nuclear power plants (450th RSK meeting on 26 and 27 September 2012)
- RSK statement: Minimum value of 0.1g (approx. 1.0 m/s²) for the maximum horizontal ground acceleration in an earthquake (457th RSK meeting on 11 April 2013)
- RSK statement: Assessment of the coverage of extreme weather conditions by the existing design (462nd RSK meeting on 6 November 2013)
- RSK statement: Hydrogen release from the containment (475th RSK meeting on 15 April 2015)

The updated plant-specific activities of the National Action Plan are given in Appendix 6 in excerpts.

Challenge 2: Guiding nuclear installations permanently shut down towards decommissioning

Since 2011, there have been different approaches to meeting the challenges of the expected large number of decommissioning licences in the coming years. These concern on the one hand measures to ensure the safety of the nuclear installations in the post-operational phase and on the other hand measures to speed up the licensing procedures for the decommissioning and dismantling of the installations that have been permanently shut down. This includes e.g.

1. the establishment of an ad-hoc working group “Post-operation prior to decommissioning” of the FARS (from the end of 2011 until the beginning of 2013)
2. a statement by the Technical Committee for Legal Matters on the post-operational phase
3. performance of safety reviews in all nuclear installations in the post-operational phase
4. preparation of a checklist for the performance of an assessment of the current safety status of an installation in the post-operational phase
5. adaptation of the regulations governing the technical qualification of shift personnel in nuclear installations especially for the post-operational phase
6. organisational measures to speed up licensing procedures
7. a statement by the Nuclear Waste Management Commission on the further procedure in connection with decommissioning projects and revision of the ESK guidelines for the decommissioning of nuclear facilities
8. updating of the decommissioning guideline of 2009 (pending)
9. promotion of research projects on aspects of a delayed transition from operation to decommissioning and until the installations are free from fuel.

Work is continuing.

14 (ii) Verification of safety

Regulatory requirements

During the operation of the installation, the provisions of the AtG and the statutory ordinances in pursuance thereof have to be complied with. The orders and directions issued hereunder by the nuclear licensing and supervisory authorities and the terms and conditions of the notice granting the licence or general approval as well as any subsequently imposed obligations have to be strictly adhered to.

Detailed requirements for monitoring, in-service inspections and other inspections are to be laid down in the operating manual according to KTA safety standard 1201 “Requirements for the Operating Manual” and in the testing manual according to KTA safety standard 1202 “Requirements for the Testing Manual”.

Regular verification of safety by the licence holder

The responsibility of the licence holder requires that the safety of the installation is in compliance with the provisions of the valid operating licences throughout its entire operating life. In line with the principle of dynamic damage prevention, the necessity and adequacy of improvements has to be checked – especially whenever new safety-relevant findings are available.

The licence holder is legally obliged by the licence to show through regular in-service inspections that the plant characteristics that are relevant for the safety of the installation as well as the safety and barrier functions are given. This is to ensure the quality and effectiveness of the safety-related measures and equipment. The corresponding provisions are contained in the licences, the safety specifications, and the safety documentation. The in-service inspections include functional tests performed to verify functional performance as well as non-destructive tests to verify faultless condition. Moreover, the licence holder plans and performs regular and preventive maintenance of the systems of the installation during operation and evaluates 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)). Test performance is specified depending on the testability of the respective system function. The objective here 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 specifications for performing the tests are reviewed regularly considering operating experience and new findings from safety research, and are adapted if necessary. 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 PWR installation.

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

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

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

Items	during operation	during outage	Total
Visual and functional tests	2850	1000	3850
Radiation protection	370	20	390
Lifting equipment	70	10	80
Non-destructive tests	10	35	45
Civil engineering	45	15	60
Plant security	130	5	135
Total	**3475**	**1085**	**4560**

Ageing management

Comprehensive measures have been implemented at an early stage in German nuclear installations to counter the inadmissible effects from the ageing of technical equipment and materials. These measures are, in particular

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

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. The “Safety requirements for Nuclear Power Plants” contain requirements for an IMS that also has to take into account the objectives and requirements in connection with ageing.

KTA safety standard 1403 contains requirements for technical and organisational measures with respect to an early detection of ageing phenomena relevant to the safety of nuclear installations and to maintaining the actually required quality condition. The licence holders shall accordingly install a systematic and knowledge-based ageing management system as part of an IMS that is to be organised, documented, assessed and updated. Ageing management is to be performed on the basis of a structured knowledge base and implemented in a process-oriented way and is to be integrated into the operational procedures.

In accordance with KTA safety standard 1403, the licence holders report to the nuclear supervisory authorities in their annual status reports on ageing-relevant activities and measures as well as about findings and results from the monitoring of their installations. The status reports contain a summarising assessment of the effectiveness of the ageing management system and of the quality or changes in the quality of the technical equipment. The presently available status reports confirm the current effectiveness of the ageing management systems in the nuclear installations. Whenever a potential for improvements is or was recognised, measures are or were taken.

Measures for internal reviews of the licence holders

WANO Peer Reviews

As members of WANO, the licence holders have placed themselves under the obligation to subject their nuclear installations and their company headquarters to WANO Peer Reviews, referred to in the latter case as "Corporate Peer Reviews". With the WANO Peer Reviews, the safety-relevant processes are reviewed and assessed by international experts on a mutual basis. The reviews also serve for "being able to recognise best practices for operational and management processes from the nuclear installations and for considering the design of the installation in the evaluation of operating experience. The aim is a performance improvement of operation regarding reliability and safety. So-called follow-up reviews appraise the implementation of selected optimisation measures.

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

For a second cycle for the performance of WANO peer reviews, the following plants were reviewed again: Emsland (2010), Brunsbüttel (2010), Brokdorf (2011), Neckarwestheim (2012).

Peer Reviews for the nuclear installations at Grohnde, Gundremmingen and Grafenrheinfeld took place in the year 2013 and for the Isar power plant site in the year 2014. In 2015, one WANO Peer Review each took place at Philippsburg and at Emsland. In 2016, a WANO Peer Review was carried out at the Brokdorf plant.

Until the final shutdown of the last remaining German nuclear power plants in 2022, 10 further WANO Peer Reviews are planned, starting in 2017: Neckarwestheim (2017 and 2020), Philippsburg (2018), Brokdorf (2019), Isar (2018 and 2020), Grohnde (2017 and 2019), Gundremmingen (2018) and Emsland (2019).

Apart from the WANO Peer Reviews at the installations themselves, there have been two Corporate Peer Reviews so far, carried out at the company headquarters of E.ON Kernkraft GmbH (2009) and RWE Power AG (2014). A second Corporate Peer Review is planned for E.ON Kernkraft GmbH in the year 2017 and RWE Power AG in 2019. The Corporate Peer Review for EnKK is to take place in the year 2017.

National Peer Reviews

Based on the WANO Peer reviews, the licence holders of the German nuclear installations carry out national peer reviews. The aim of this initiative – analogous to WANO Peer Reviews – is to obtain representative statements on the quality of the administrative/operational management at the nuclear installations and, if necessary, implement optimisations. The respective topics on each occasion are chosen by a VGB committee guided by current needs and are then reviewed in all nuclear installations.

In all, a large number of recommendations were made as a result of the reviews that have led to improvements in the nuclear installations. However, the benefit to the German nuclear installations is generated not just by the teams' recommendations but also by the knowledge gain of the peers from the German nuclear installations who are deployed in large numbers to take part in international WANO Peer Reviews.

OSART missions

The IAEA offers OSART missions as a service. OSART missions are carried out on application of a member state and with approval of the IAEA on a voluntary basis. The aim of these missions is to support the member states in improving the operational safety of individual nuclear installations. Moreover, they serve for the continual development of operational safety in all member states by the dissemination of good practices. The acceptance and application of IAEA Safety Standards which represent the assessment criteria of the missions – are to be improved, too. The target group regarding the results of these missions are the licence holders as well as the competent licensing and supervisory authorities.

In Germany, the IAEA has so far carried out six OSART missions upon invitation. These took place mainly in the late 1980s and early 1990s: Biblis A (PWR) in 1986, Krümmel (BWR) in 1987, Philippsburg 2 (PWR) in 1987 and 2004, with a follow-up in 2006, Grafenrheinfeld (PWR) in 1991 (follow-up mission in 1993).

The most recent OSART Mission to Germany was carried out at Neckarwestheim in the year 2007. The Follow-up Mission in May 2009 showed that a large proportion of the suggestions resulting from the mission had already been implemented and that sufficient progress had been achieved with regard to the remaining suggestions.

The German Federal Government, represented by the BMUB, are planning to have an OSART mission carried out on one of the German nuclear power plants still in operation.

Reviews within the framework of state supervision

The nuclear licensing and supervisory authority monitors and, if necessary, enforces the fulfilment of the licence holder's obligations relating to the licence (§ 17 AtG).

In addition to the inspections performed by the licence holder, safety verifications are performed within the framework of regulatory supervision by the competent nuclear licensing and supervisory authority of the *Länder*. These verify by means of different methods whether the licence holders meet their obligations. The choice of method depends, among other things, on the plant state, e.g. construction, operation, outage or implementation of modification.

Accompanying inspections during construction, commissioning and modification

During the construction and commissioning phase, the experts called in by the licensing and 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 carried out by the manufacturer, which are 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)).

Inspections during operation

The nuclear licensing and supervisory authority of the respective *Land* carries out regular tests and controls during inspections of the nuclear installation, aided in most cases by authorised experts. Such inspections may be aimed at the clarification of specific issues or be performed with the objective of a general plant walkdown.

For example, the following areas are inspected by the nuclear licensing and supervisory authority as part of an on-site inspection:

- structures
- confinement
- reactor core
- reactor coolant system
- reactor auxiliary and supporting systems
- ventilation systems
- water-steam cycle
- auxiliary and component cooling systems
- plant auxiliary systems
- electrical equipment
- measuring, governing and control systems
- reactor protection system
- matters concerning the overall installation
- radiation protection
- fire (explosion) protection equipment
- physical protection

For the respective areas, the on-site inspections focus on the following:

- condition/implementation as well as function and properties of the installed system on site regarding its conformity with the officially licensed or approved construction
- maintenance or repair (including operational monitoring) of the installed system on site regarding the maintenance of its flawless condition including its conformity with the operating rules
- operation of the installed system regarding compliance with the safety-related requirements including its conformity with the operating rules
- confinement or retention of the activity regarding activity flow or activity inventory including conformity with the operating rules
- documented status of the valid operating regulations regarding current updating including conformity with the rules
- matters of radiation protection, fire protection and physical protection regarding the consideration of the present requirements including conformity with the operating rules
- residual materials disposal regarding treatment in compliance with the specifications and regulations
- plant documentation regarding conformity with the regulations

- technical qualification/training of the personnel regarding maintenance of the level of training in line with the requirements including treatment in conformity with the regulations
- quality management regarding conformity with the regulations
- ageing management regarding conformity with the regulations
- safety management regarding conformity with the regulations

Site inspections are generally aimed at reviewing the installed systems, documents and records through visual inspection on site at the installation. The relevant site inspection means/methods are therefore – depending on the kind and scope of the inspection:

- integrated visual inspection
- specific visual inspection
- inspection of the operating records
- specific review of documents of the operating/quality documentation
- recording of matters in writing
- plausibility assessments and minor control calculations and measurements that can be carried out on site
- comparative tests (“status quo”/”desired condition”)
- gauging/recording of process-based state variables
- recording of the “as-built” condition
- interviews with the operating personnel.

The on-site inspections with the associated tests also provide a set of tools that enable the nuclear supervisory authority to assess the influencing factors of man, technology and organisation in the way they interact.

The in-service inspections carried out by the licence holder on safety-relevant components are accompanied by authorised experts of the nuclear licensing and supervisory authorities at specified intervals. Besides such inspections without special cause, other inspections also take place due to reportable events or other findings; in these cases, the nuclear licensing and supervisory authority and authorised experts on site want to form their own opinion on the findings made.

The licence holders are obligated, e.g. by licensing requirements, to submit written reports on various topic areas. These include e.g. matter of operation, safety and radiation protection including environmental monitoring as well as the stock and whereabouts of radioactive materials. These reports are evaluated by the nuclear licensing and supervisory authority, subordinate authorities or authorised experts consulted for this purpose.

The current operating condition of the nuclear installations is monitored directly by the nuclear licensing and supervisory authority of the *Land* or a subordinate authority with the help of the KFÜ (→ Article 15). With this transmission system, authority staff can monitor online the relevant operating parameters and emission data of the installation. The values that are transmitted are updated at short intervals and saved so that they are still available at a later time if needed for queries. If specified limits are exceeded, the nuclear licensing and supervisory authority is alerted automatically.

Implementation of the “Vienna Declaration on Nuclear Safety”

In Germany, PSRs as demanded within the framework of the “Vienna Declaration on Nuclear Safety” have been performed since the 1990s already, as has been described above. In 2002, the obligation of a decennial safety review of each nuclear installation in power operation was anchored in the AtG (§ 19a AtG). Based on the results of the safety reviews, backfitting measures were carried out on existing installations to continually enhance the safety of the installations as required in § 19a AtG.

By continual backfitting, the level of safety of the German nuclear installations is to be maintained or improved. Since the national report for the Sixth Review Meeting, various measures have been carried out in this respect. Examples are

- preventive emergency measures that have been implemented for all installations in power operation,
- an HMN that was prepared for the crisis team, and
- robustness analyses for the beyond-design-basis area that were carried out by the licence holders of the nuclear installations.

Results that are seen in connection with the activities to implement the “Vienna Declaration on Nuclear Safety” can be found in this Article under “Backfitting measures and improvements performed and current activities”.

Regarding nuclear installations which as of the year 2015 are in a final state of transition from power operation to post-operation, the licence holder has to carry out a safety analysis for the post-operational phase on the basis of the “Checklist for the performance of an assessment of the safety status of the installation for the post-operational phase”.

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 of rules and regulations

Basic regulatory requirements

The StrlSchV is the legal basis for the handling of radioactive substances. It is adapted to the Basis Safety Standards of the EURATOM which lay down the framework for radiation protection in the EU. The ordinance includes provisions by which man and the environment are protected from damage due to natural and man-made ionising radiation. It specifies requirements and limits applied regarding the use and impact of natural and man-made radioactive substances and ionising radiation. This especially covers the handling of nuclear fuel as well as construction, operation and decommissioning of nuclear installations (as defined in § 7 AtG). Organisational and physical and technical protective measures as well as medical surveillance are prescribed. Moreover, licensing obligations are regulated for the handling of man-made radioactive substances, for their import, export and their transport.

Relevant to practices in terms of the StrlSchV are the radiation protection principles laid down therein:

- justification
- limitation of doses, and
- avoidance of unnecessary radiation exposure and dose reduction-

Together with the principle of proportionality – a constitutional principle to be accounted for in all cases – these principles result in an obligation to optimise radiation protection in terms of the ALARA principle (As Low As Reasonably Achievable).

The main dose limits for the annual effective dose, organ doses and the lifetime dose specified in the StrlSchV are listed in Table 15-1.

Requirements for the protection of workers

The limit specified for the body dose of occupationally exposed persons is a maximum effective dose of 20 mSv per calendar year. In individual cases, an effective dose of 50 mSv may be authorised by the competent licensing and supervisory authority in a single year, provided that a dose over any five consecutive years does not exceed 100 mSv. Other limits are stipulated for organs and tissues. Stricter limits apply to persons under the age of 18 and women of childbearing age.

For the determination of body doses, the personal dose is usually measured by means of electronic dosimeters by the licence holder and with official passive dosimeters. In addition to the measurement of the dose from external exposure, the dose due to incorporation is usually determined by monitoring of the airborne activity concentration or by measuring whole-body or partial body doses.

The measuring institutions designated by the competent nuclear licensing and supervisory authorities transmit the values of official dosimetry, usually measured monthly, to the radiation protection supervisor or radiation protection officer and to the central Radiation Protection Register.

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

§	Scope of applicability	Time period	Limit [mSv]
Dose limits for occupationally exposed persons			
55	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	Calendar year	150
55	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 child-bearing 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).		
Design and operation of nuclear installations			
46	**Environment of nuclear installations**		
	Effective dose: direct radiation from nuclear installations including discharges	Calendar year	1
	Organ dose: eye lens	Calendar year	15
	Organ dose: skin	Calendar year	50
47	**Limits for 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	**Accident planning levels for nuclear installations**		
	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

For occupationally exposed persons, a distinction is made between Categories A and B. Persons with a potential occupational radiation exposure of more than 6 mSv per year or 45 mSv organ dose for the eye lens or 150 mSv organ dose for skin, hands, forearms, feet and ankles are classified as Category A. For these persons, occupational medical health examinations by authorised physicians are provided on an annual basis. For persons of Category B, medical examinations are only performed if specifically requested by the competent nuclear licensing and supervisory authority.

Moreover, a radiation passport is to be maintained for persons working in foreign radiologically controlled areas. The general administrative provision on the radiation passport [2-2] ensures that all exposures from practices or in connection with work in the environment of naturally occurring radionuclides are taken into account for this group of persons, thus ensuring that the dose limits specified in the StrlSchV are complied with on the basis of the overall exposure from all areas of application.

Requirements for 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 members of the public during specified normal operation of nuclear installations are laid down in § 46 and 47 StrlSchV (→ Table 15-1).

Any radioactive discharge is recorded nuclide-specifically according to type and activity, thus enabling the calculation of radiation exposure in the vicinity of the installations. The analytical models and parameters used to determine the exposure of the public are specified in the StrlSchV and in the general administrative provision on the determination of radiation exposure from discharge of radioactive substances from nuclear installations or facilities [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

The planned structural and technical measures for the control of design basis accidents are central issues evaluated during the licensing procedures for nuclear installations (→ Article 18 (i)). In accordance with § 49 StrlSchV, it is to be demonstrated, without prejudice to the requirements of § 6 StrlSchV, that in the vicinity of the installation in case of the most unfavourable design basis accident an effective dose of 50 mSv (accident planning level) is not exceeded by the release of radioactive substances into the environment. To this end, all exposure pathways are to be considered as a 50- or 70-year dose commitment. Further planning levels apply to specified organs and tissues. The analytical models and assumptions to be applied for verification purposes are specified in the incident calculation bases for the guideline for the assessment of the design of nuclear power plants with PWR according to § 28 para. 3 StrlSchV [3-33.2].

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

Due to the design of the nuclear installations, these accidents are very improbable. For these, specification of dose limits or 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 PSAs, organisational and technical measures were taken within the framework of accident management for the protection of the public in order to control beyond-design-basis plant states or at least to mitigate their consequences inside and outside the installation (→ 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.

Implementation of the ALARA principle

The protection of the personnel working in nuclear installations has already been considered during the design of the nuclear installations by implementing the provisions of the StrlSchV and subordinate legislation (e.g. the guideline for radiation protection of personnel during the execution of maintenance work in nuclear power plants with light water reactors, Part 1 [3-43.1] and safety standard KTA 1301.1). The design-related aspects are also taken into consideration in case of significant modifications of nuclear installations. In addition, organisational and technical measures are specified for the reduction of radiation exposure of personnel during operation (in particular the guideline concerning the radiation protection of personnel during maintenance, modification, waste management and dismantling work in nuclear installations and facilities, Part 2 [3-43.2] and safety standard KTA 1301.2).

The planning processes regarding the required radiation protection measures to be taken when carrying out activities in nuclear installations are dependent on the individual and collective doses to be expected as well as on the radiologically relevant boundary conditions. Radiation protection has principally to be included in the planning at an early stage. Depending on the individual case, the planning is also subject of reviews by the nuclear supervisory authority.

In general, the basic ideas of the ALARA principle are included in the licence holders' radiation protection measures. These are geared to, among others,

- involving the management in radiation protection responsibilities and the support of the implementation,
- the decision-making strategy to solve the issue of meeting complex radiation protection requirements,
- the proportionality of the radiation protection measures, and
- the evaluation of experience and experience feedback.

The requirements together with the increased radiation protection awareness among the personnel and the involvement of the nuclear licensing and supervisory authorities in the review of the planning of radiation protection measures and their implementation provide a good basis for the implementation of the ALARA concept with the aim to reduce exposures and optimise radiation protection measures in the installations.

An example of the improvement of the radiologically relevant boundary conditions represents the primary circuit system decontamination performed in some nuclear installations, in particular for nuclear installations in the post-operational phase. This measure allows to permanently reduce the radiation exposure of personnel during the planned activities.

Emission and immission monitoring

Maximum permissible activity amounts and concentrations for the discharge of radioactive substances are defined by the nuclear licensing and supervisory authorities within the framework of the procedure for granting an operating licence. These 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 the discharge does not exceed the above-mentioned limits of § 47 StrlSchV (→ Table 15-1). Together with the contribution by direct radiation, the limits of § 46 StrlSchV (→ Table 15-1) shall not be exceeded.

Discharges of radioactive substances are to be kept as low as possible, taking into account the state of the art in science and technology and taking into account all circumstances of the individual case, even where the limits are below those defined in the operating licence. Thus, for example, high demands are placed on the quality of the fuel assemblies, 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 nuclear installations are equipped with devices for the retention of radioactive substances.

Emission monitoring

The basis for monitoring and specification of emissions according to type and activity is provided by § 48 StrlSchV. The programmes for emission monitoring during specified normal operation and in case of design basis accidents comply with the guideline concerning emission and immission monitoring of nuclear installations (REI) [3-23] and safety standards KTA 1503.1, 1503.2, 1503.3 and 1504. The licence holders of nuclear installations carry out these monitoring measures and submit the results to the competent nuclear licensing and supervisory authorities.

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

The discharge of nuclides and nuclide groups with exhaust air is continuously measured for radioactive noble gases, for radioactive aerosols and for iodine-131 as well as in the waste water for gamma-emitting nuclides. Releases that may occur as a result of accidents are determined using instruments with extended measurement ranges. In addition to the measuring instruments of the licence holders, there are also instruments of the nuclear licensing and supervisory authorities whose data are transmitted online via the remote monitoring system for nuclear power plants (KFÜ).

The specification 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 water path, quantities are specified for gamma emitting nuclides, radioactive strontium, alpha emitters, tritium, iron-55 and nickel-63. Reports on the discharges specified in terms of type and activity are submitted to the nuclear licensing and supervisory authority on a quarterly and annual basis.

The direct radiation from the installation is monitored by dose measurements at the fence of the site of the nuclear installation.

To assess the effects of discharged radioactive substances, the licence holder of the nuclear installation records the site-specific meteorological and hydrological parameters with relevance for the dispersion and deposition of radioactive substances. The requirements for meteorological instrumentation are included in safety standard KTA 1508.

Immission monitoring

The licence holders of the nuclear installations have implemented a programme for immission monitoring in the vicinity of the installations as ordered by the nuclear licensing and supervisory authority. In addition, measurements are performed by independent measuring institutions on behalf of the licensing and supervisory authority.

Immission monitoring supplements emission monitoring. It allows additional control of the discharges as well as control of compliance with the dose limits in the vicinity of the installation. The REI specifies programmes for immission monitoring prior to commissioning, during specified normal operation, during incidents or accidents as well as in the phase of decommissioning and safe enclosure for the licence holder and the independent measuring institution. Site-specific circumstances and conditions are considered additionally.

The still uninfluenced environmental radioactivity and radiation exposure was recorded by measurements prior to commissioning. Monitoring measures during operation serve, among other things, to monitor long-term changes that may occur due to the discharge of radioactive substances. Incident and accident measurement programmes provide the basis for sampling, measurement and evaluation methods in the event of a design basis accident or beyond-design-basis accident. The sampling and measurement methods ensure that relevant dose contributions for the public 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 nuclear licensing and supervisory authority and are centrally recorded, evaluated and published by the BfS.

Even when using the most sensitive analysis methods, no immission in the environment will be detected that result from discharges with exhaust air. The analysis of the ground-level air, the precipitation, the soil, the vegetation and the foodstuffs of plant 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 the operational discharges with exhaust air also are not detected.

In individual cases, immissions of the water pathway can be detected in surface water. The tritium content in flowing waters can be increased by radioactive waste water discharges from nuclear installations. The values are mostly below 100 Bq/l and, depending on the discharge quantity, also considerably lower. In samples directly taken at discharge structures, also higher values in the order of some 100 Bq/l can occur. In 2013, the maximum value in the vicinity of the Emsland nuclear power plant was 3,660 Bq/l. The nuclide contents of other fission and activation products are generally below the detection limit required for these analyses. Here, too, 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 sediment samples, the average radionuclide contents are below the required detection limits. In only a few samples taken at discharge structures, cobalt-60 in a small concentration (in 2013, maximum values of 4.2 Bq/kg, Philippsburg nuclear power plant) and other fission and activation products like cobalt-58, iodine-131, caesium-137 and americium-241 can be detected. No radioactive substances were found in fishes, aquatic plants and ground and drinking water that could be attributed to the operation of nuclear installations. The increase of contents of fission and activation products caused by discharges of radioactive substances with water in these environmental areas is thus negligibly small.

Monitoring of environmental radioactivity/Integrated Measurement and Information System

In addition to the site-specific monitoring of the vicinities of the nuclear installations, 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). 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 BfS and from there on to the BMUB.

Even slight changes in the level of environmental radioactivity can be detected quickly and reliably by the measurements, 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, IMIS will be switched from routine to intense operation on the initiative of the BMUB, which essentially means that measurements and samples will be taken more frequently.

The results from these measurements are also used within the framework of international information exchange (→ Article 16 (2)). At present, the data are displayed in maps placed on the Internet (www.bfs.de) with a weekly update of the activity concentration in the air and a daily update of the local gamma dose rate in Germany. Figure 15-1 shows an example of data for the local dose rate of 2015.

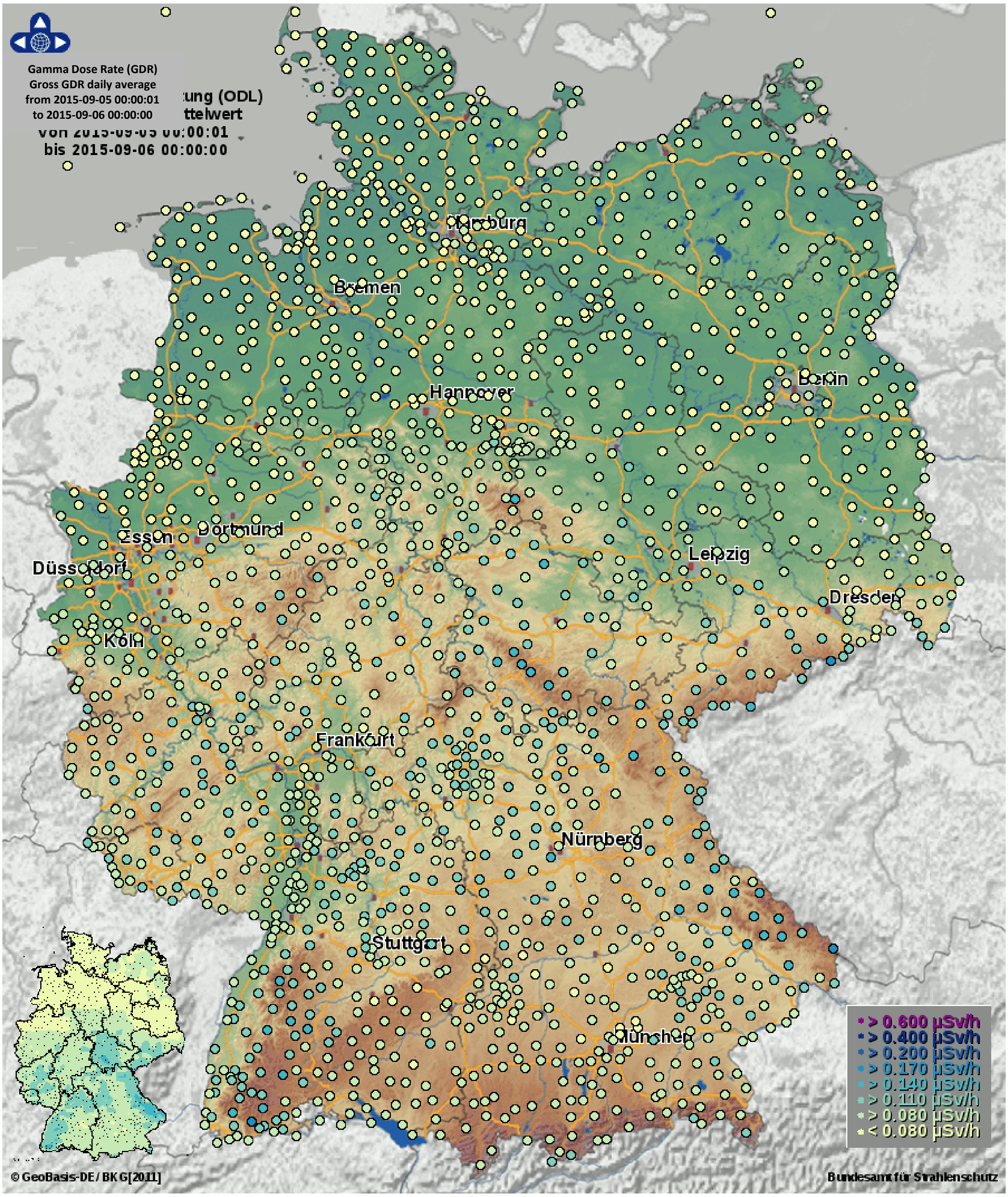


Figure 15-1 Example of the determination of environmental radioactivity by gamma dose rate measurements

Results of the implementation of radiation protection measures by the licence holder

Exposure of the personnel

Figure 15-2 shows the average collective doses per year and nuclear installation. Here, to some extent, the construction lines show different behaviours. The exposures at PWRs of construction line 4 (Konvoi plants) have been at a consistently low level since commissioning. An important contribution to this was, among others, the consistent avoidance of materials containing cobalt in almost all components of the primary system. Further structural improvements compared to previous construction lines, such as enlarged space and additional structural shieldings, also contributed to reducing radiation exposure. Construction lines 2 and 3 show a long-term reduction in the collective doses. For construction line 3, this is mainly due to the improvements in radiation protection and the small scope of backfitting activities compared to previous years. The differences from year to year are due to different scopes of revision activities during outage. For the nuclear installations of construction line 2, the change between years without any revision activities during outage and years with implementation of dose-intensive backfitting measures led to significant differences from year to year between 2000 and 2011. For 2011 and subsequent years, it can clearly be seen that the shutdown of the four remaining PWRs of construction line 2 results in significantly lower annual collective doses. For construction line 1, the curve shown is due to decommissioning in the years 2003 and 2005 and the associated smaller scope of the preceding revisions. Since May 2005, PWRs of construction line 1 are no longer in operation.

Regarding BWRs, there is a stabilisation of the collective doses for nuclear installations of construction line 69 at a level that is low for BWRs, while in the two nuclear installations of construction line 72 slightly increased outage doses during extensive revision activities led to an increase of the collective doses until 2008. With decreasing scopes of revisions, the average annual collective dose stabilises at a lower level in the following years compared to 2008. As in the case of PWRs of construction line 2, the shutdown of the four remaining BWRs of construction line 69 also leads to a significant reduction of the average annual collective dose in 2011 and subsequent years due to the significantly reduced scope of activities performed.

Discharge of radioactive substances during operation of the installations

Results of emission monitoring

Except for tritium, the annual discharges are only in the order of a few percent of the specified limits. The data on discharges of radioactive substances with exhaust air and water are published by the Federal Government in its annual report “Environmental Radioactivity and Radiation Exposure” submitted to the *Bundestag* (the German Federal Parliament), and in an additional more detailed annual report with the same name issued by the BMUB. Discharges from German nuclear installations are shown in Figures 15-3 and 15-4.

Radiation exposure of the public during specified normal operation

The results of the calculation of radiation exposure of the public show (→ Figures 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 implemented at the nuclear installations in operation, the filtering devices installed and fuel assembly defects to only a small extent. 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 reference person defined in the StrlSchV (a reference person behaving as unfavourable as possible with regard to radiation exposure). For waste water, the resulting exposures are even lower with values of generally less than 1 µSv. These calculations were carried out according to the general administrative provision on the determination of radiation exposure from discharge of radioactive substances from installations or facilities.

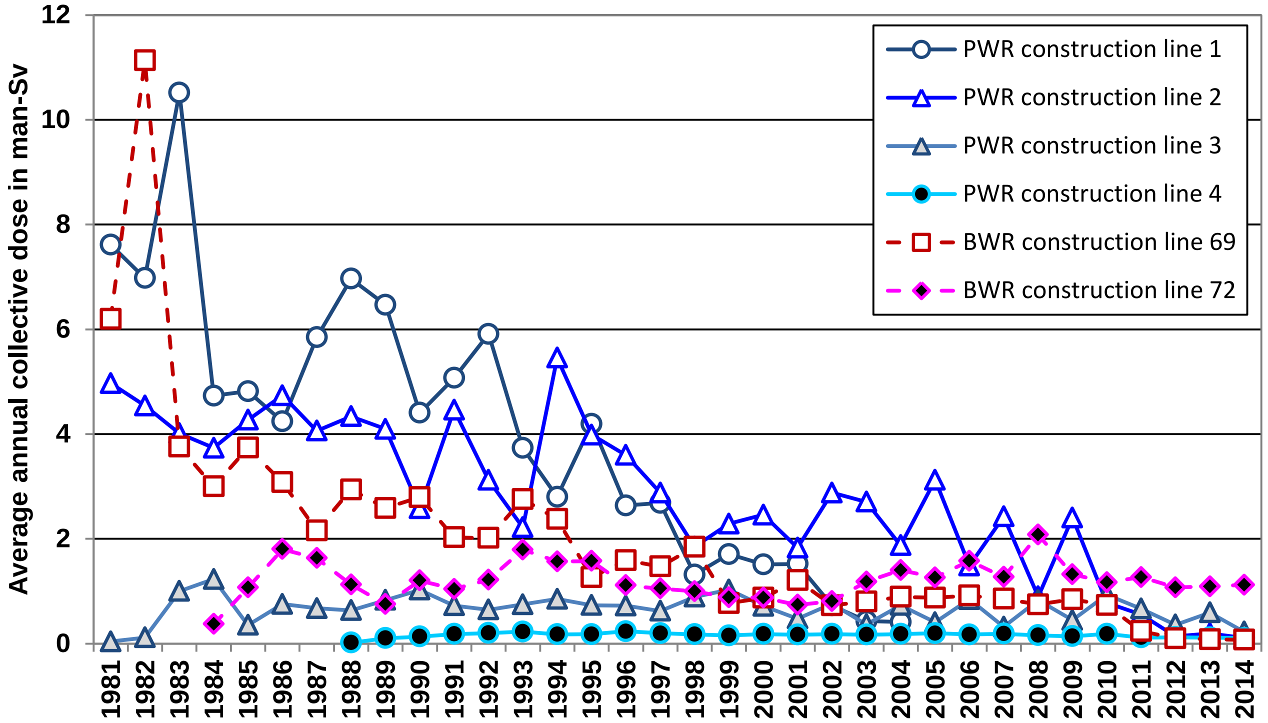


Figure 15-2 Average annual collective dose of the nuclear installations per year and installation

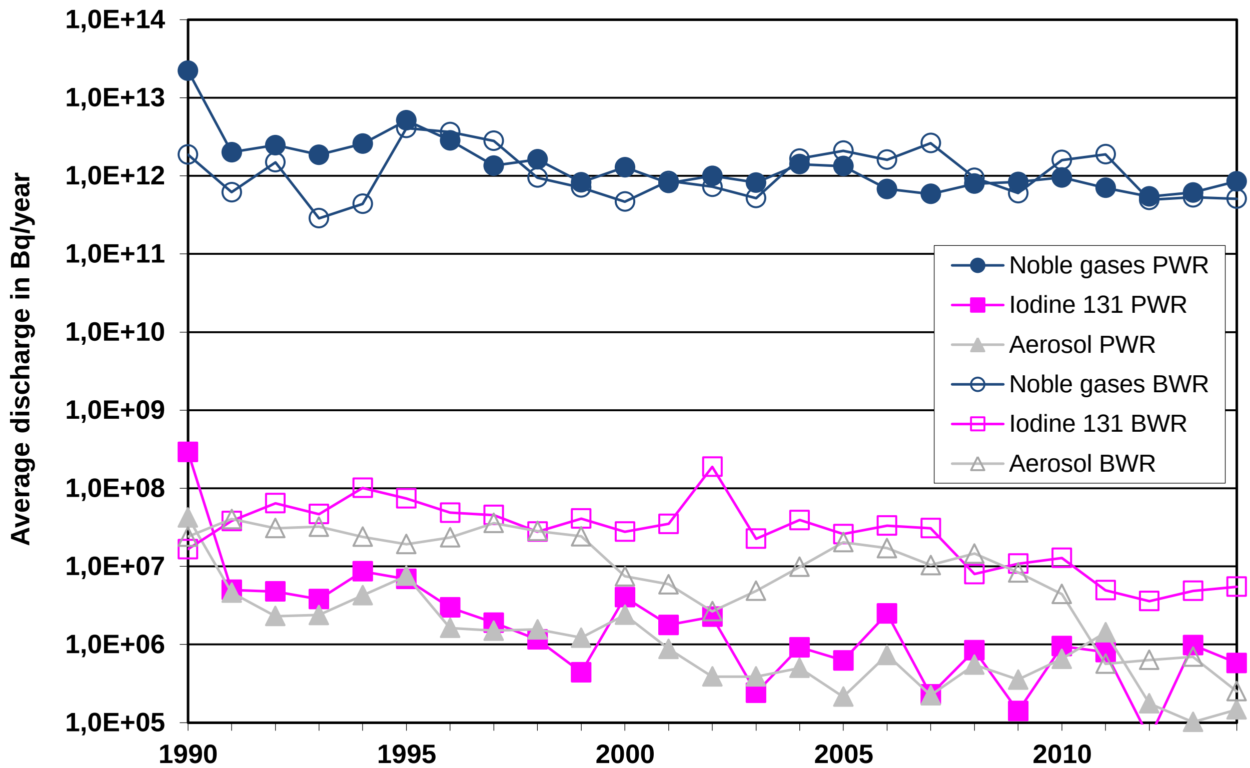


Figure 15-3 Annual average discharge of radioactive substances with exhaust air from PWRs and BWRs in operation

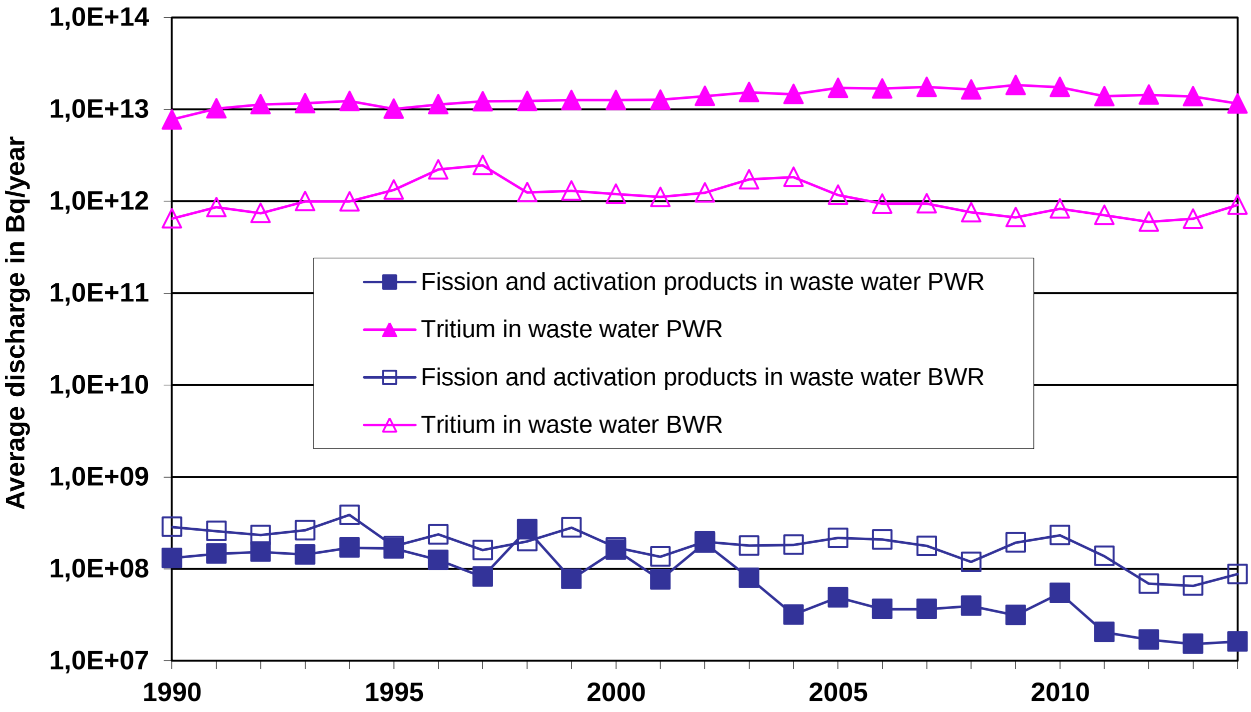
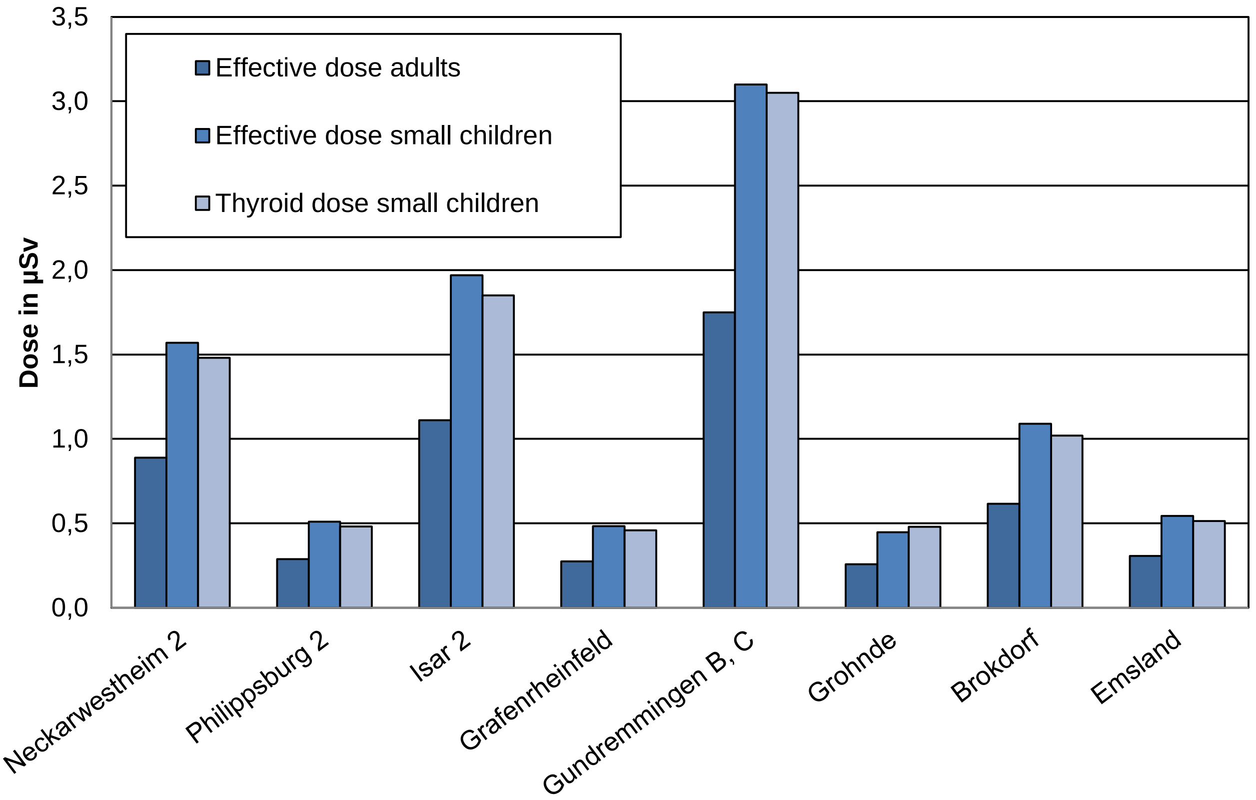
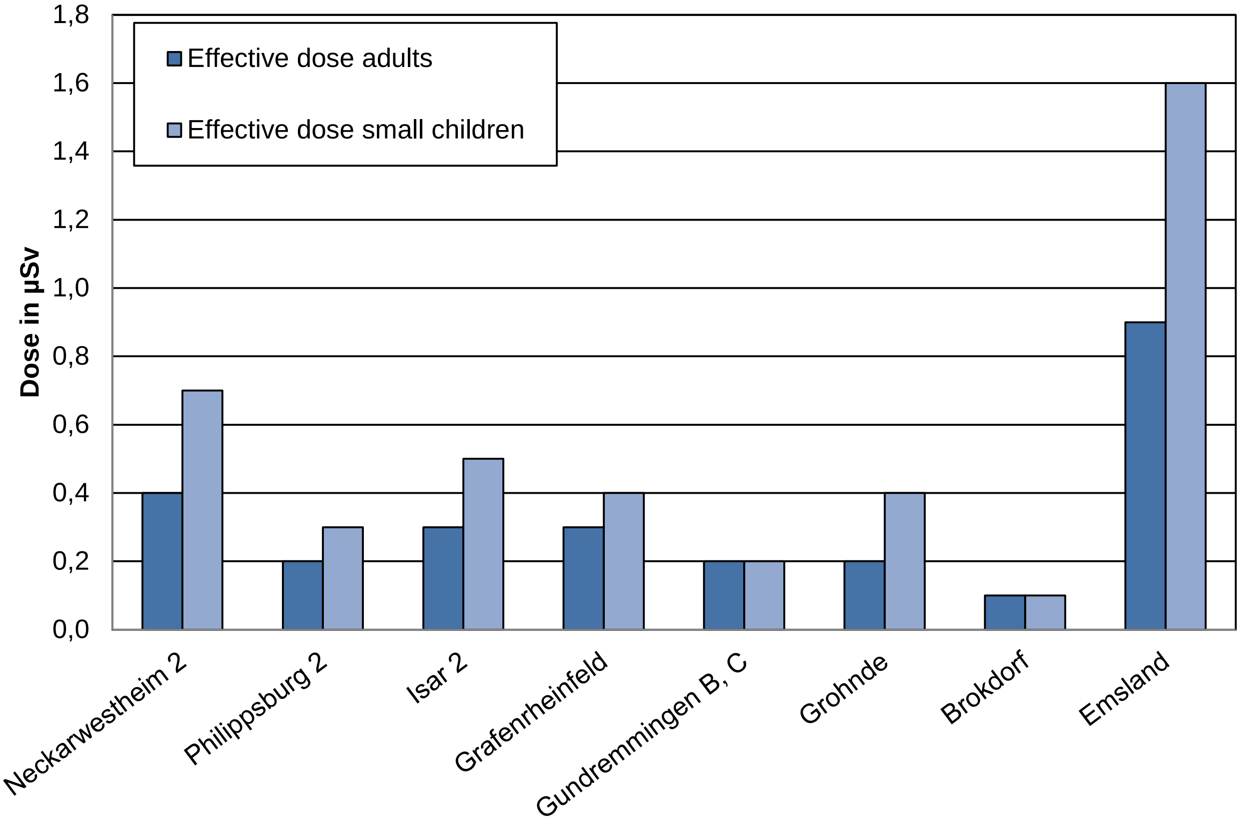


Figure 15-4 **Annual average discharge of radioactive substances with waste water from PWRs and BWRs in operation**



Note: Values < 0.1 µSv are displayed as 0.1 µSv.

Figure 15-5 **Radiation exposure in 2014 in the vicinity of the nuclear installations in operation due to discharges with exhaust air**



Note: Values < 0.1 µSv are displayed as 0.1 µSv.

Figure 15-6 Radiation exposure in 2014 in the vicinity of the nuclear installations in operation due to discharges with waste water

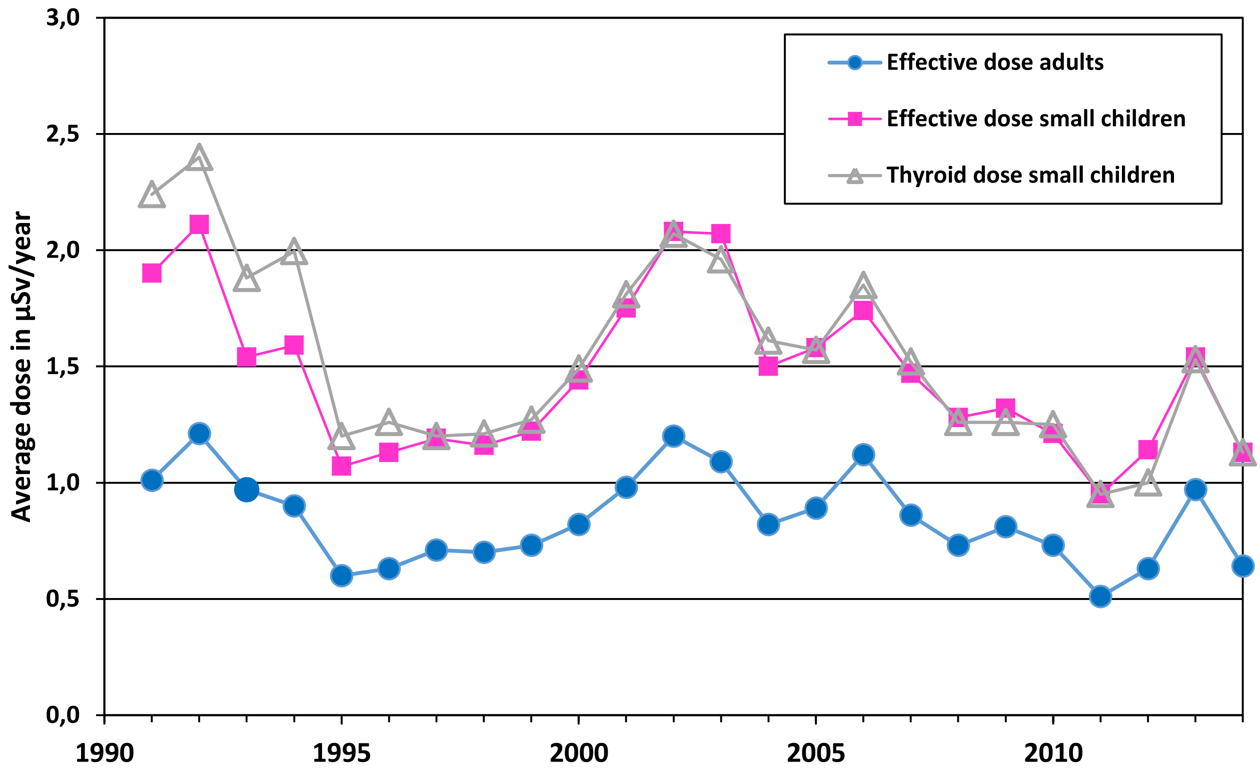


Figure 15-7 Radiation exposure in the vicinity of the nuclear installations in operation due to discharges with exhaust air

Regulatory review and monitoring

Emission monitoring

Primarily, emission monitoring is the responsibility of the licence holder who causes the emissions (self-monitoring). The licence holder has to specify the discharges of radioactive substances according to type and activity and furnish proof of compliance with the maximum permissible (licensed) discharges to the licensing and supervisory authority. The licence holder supplements the proof of compliance with the dose limits by means of an additional measurement programme for the monitoring of the vicinity of the installation or facility.

Correct performance and specification of the results of emission monitoring according to type and activity by the licence holder (self-monitoring) is verified by an independent measuring institution.

According to the guideline on the verification of the licensee's monitoring of radioactive effluents from nuclear power plants [3-44], the BfS performs additional controls. For the control of emission monitoring of exhaust air, control measurements are performed on aerosol filter samples, iodine filter samples, tritium samples and carbon-14 samples, and comparative measurements are performed at the plant for determining the emission of radioactive noble gases. For controlling emission monitoring of water, samples are analysed for gamma-emitting nuclides, tritium, strontium and alpha emitters. The results of the control measurements are submitted to the nuclear licensing and supervisory authorities. If the results of the measurements carried out by the licence holder 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 type and activity are specified correctly.

In addition, the licence holders are required to participate in round robin tests.

Immission monitoring

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

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

Besides direct supervisory radiation protection measures in the individual nuclear installations, the respective nuclear licensing and supervisory authorities also monitor the emission and immission of radioactive substances with exhaust air and waste water. For immission monitoring, the competent nuclear licensing and supervisory authorities of the *Länder* operate measuring systems and facilities to be able to detect increased discharges of radioactive substances, e.g. in case of an incident, at an early stage.

Within the scope of his responsibility for emission monitoring, the licence holder regularly reports to the competent nuclear licensing and supervisory authority on the discharges of radioactive substances which are reviewed for completeness, plausibility and consistency. In doing so, data of 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 and, where required, additional measurements (special measurements) are initiated for clarification. In addition, correct performance and specification of the results of emission monitoring according to type and activity is verified by measurements of an independent measuring institution.

Remote monitoring of nuclear power plants

In addition to the self-monitoring of the licence holder, the competent nuclear licensing and supervisory authorities of the *Länder* operate their own systems for continuous acquisition of measurement data (KFÜ).

Main functions of the KFÜ are the continuous emission monitoring, which is partly designed redundantly to the self-monitoring of the licence holders, and immission monitoring in the vicinity of the plants. Furthermore, meteorological data are continuously transmitted to the nuclear licensing and supervisory authority. Various operating parameters provide information on the operational 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 nuclear licensing and supervisory authority in the case of excess of permitted values. Further processing of these data in connection with meteorological factors in appropriate computer codes allows assessing and predicting the radiological exposure in the vicinity of the plants, in particular after release of radioactive materials in case of design basis or beyond-design-basis accidents. Thus, the results also serve the purposes of disaster control.

Progress and changes since 2013

In the field of regulatory guidance, the new nuclear regulations "Safety Requirements for Nuclear Power Plants" were published in 2013, which summarise requirements for radiation protection. To specify these safety requirements, interpretations were prepared for further elaboration of the requirements. One of these interpretations specifies the requirements relating to radiation protection ("Requirements for radiation protection").

Moreover, the guideline for the technical qualification of radiation protection officers at installations for fission of nuclear fuels [3-61] has been revised and was published in 2014. Furthermore, several KTA safety standards with relevance for radiation protection have been updated, e.g. the standard on radiation protection during operation of nuclear installations (safety standard KTA 1301.2), on monitoring of radioactivity in the inner atmosphere of nuclear installations (safety standard KTA 1502), on monitoring the discharge of radioactive gases and airborne radioactive particulates (KTA safety standards 1503.1, 1503.2 and 1503.3) as well as on monitoring the discharge of radioactive substances with water (safety standard KTA 1504).

Future activities

Due to the implementation of Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, legal regulations related to radiation protection are currently revised and updated (→ Article 7).

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).

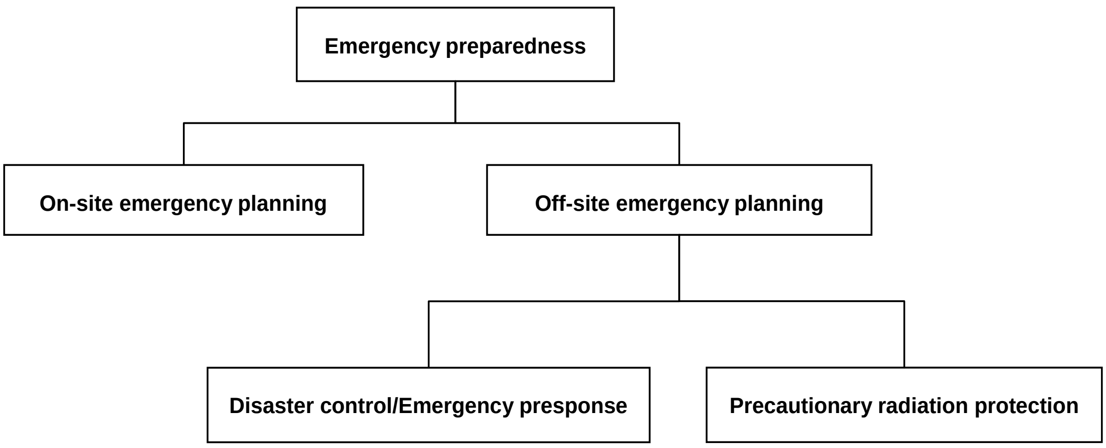


Figure 16-1 Structure of emergency preparedness

On-site emergency planning is realised by technical and organisational measures taken at nuclear installations 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 damage situations by means of precautionary protection of the population and serves for preventive health protection. Within the framework of precautionary radiation protection, environmental radioactivity is monitored continuously all over the territory of the Federal Republic. This is to ensure an early detection of any increased radioactivity in the environment. Based on the StrVG, it is furthermore possible to issue recommendations to the population on how to behave and to impose bans and restrictions on foodstuffs, feedstuffs, medicines and other substances.

16 (1) Emergency preparedness, emergency plans

Legal and regulatory requirements

Based on the regulations of the AtG, the StrVG, the StrlSchV and the disaster control laws of the *Länder*, the planning of emergency preparedness is described by the subordinate regulations and by recommendations.

The measures to cope with emergencies implemented by the licence holder and laid down in the alarm regulation contained in the BHB, the NHB and the HMN are based on the "Safety Requirements for Nuclear Power Plants" and their "Interpretations", on recommendations of RSK and SSK and of REI as well as on various KTA safety standards. In 2014, SSK and RSK's joint "Basic recommendations for the planning of emergency control measures by the operators of nuclear power plants" [4-13] were revised. These contain general requirements for on-site emergency planning on the part of the licence holders of nuclear installations.

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] (referred to in the following as "Basic Recommendations") and by the SSK-recommendation on "Planning areas for emergency response near nuclear power plants" [4-18].

Principles and explanations are described in the associated "Basic Radiological Principles for Decisions on Measures for the Protection of the Population against Incidents involving Releases of Radionuclides". As a recommendation jointly prepared by the Federation and the *Länder*, the "Basic Recommendations" form the basis for planning of disaster control in the vicinity of the plant. [3-15.2]. They determine, among others, the planning areas, measures and further provision of the licensing and supervisory authorities and the documents required.

The StrVG stipulates the tasks and powers of the nuclear licensing and supervisory authorities of the Federation and the *Länder* in precautionary radiation protection. It regulates the monitoring of the radioactivity in the environment and appropriate measures to keep the radiation exposure of man and the radioactive contamination of the environment as low as possible in the case of events with possible considerable radiological consequences, taking into account the state of the art in science and technology as well as all circumstances. For this purpose, the StrVG contains specifications regarding

- measuring tasks of federal and *Land* authorities to monitor radioactivity in the environment,
- establishment of an IMIS including a ZdB for monitoring radioactivity in the environment,
- authorisation to define dose and contamination limits,
- authorisation to ban or restrict the use of foodstuffs, feedstuffs, drugs or other substances,
- authorisations concerning cross-border traffic and
- official recommendations concerning certain modes of conduct for the population that may be given by the BMUB or, in the case of events with exclusively local consequences, by the competent supreme *Land* authority.

After the nuclear accident at Chernobyl, the European Union specified limits of radioactivity in foodstuffs and feedstuffs that are immediately applied by the EU Commission in a radiological emergency. General administrative provisions were passed at national level for verifying compliance with these limits.

A guideline important for determining the situation is the REI, which specifies, in addition to the necessary measurements during normal operation, the 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 licence holder of a nuclear installation. Off-site emergency planning falls within the competence of the respective authorities of the *Länder* and the Federation (→ Figure 16-2).

Licence holder of a nuclear installation

The licence holder 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 any incidents and accidents.

The measures are divided into preventive and mitigative measures. The general objective of the preventive measures is to reach and maintain a condition of the installation that will not lead to any dangerous consequences and to prevent accidents involving severe fuel damage. The mitigative measures aim at limiting consequences if core damage is impending or has already occurred. The RSK and the SSK have jointly formulated general recommendations for the planning of emergency protection measures by the licence holder. These were last revised in 2014 and now include amongst other things the lessons learned from the nuclear accident at Fukushima. The licence holders' emergency plans ensure that these measures can be implemented immediately.

In case of an emergency, the licence holder immediately informs the competent authorities as soon as the specified prerequisites for an alarm are fulfilled. The licence holder is obliged to make any information necessary for averting danger available to the authorities in time and appropriate to the situation and to advise and support the authorities in assessing the situation and in taking decisions on protective actions for the population.

Authorities of the *Länder*

Averting of danger by disaster control is a task of the *Länder* which, to this end, passed special 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 licensing and 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 coordination is required between the *Land* authorities responsible for disaster control and the federal and *Land* authorities responsible for precautionary radiation protection.

In case of need, the BMUB makes its resources available for providing support and advice to the *Länder*. These resources also comprise the BfS and GRS as well as the BMUB's advisory committees RSK and SSK. Within the framework of precautionary radiation protection, the Federation is authorised to decree legal provisions encompassing dose and contamination limits or bans and restrictions regarding foodstuffs, feedstuffs, medicines and other substances. As a general principle, the StrVG and the federal ordinances decreed on its basis are executed by the *Länder* on behalf of the Federation (see Article 8 above for the execution by the *Länder* on federal commission) as far as the StrVG does not explicitly state that federal administrative authorities are responsible for specified tasks. By means of the IMIS, for example, the Federation monitors and assesses the radiological situation in Germany both during routine operation and under incident and accident conditions, with measurements and samples taken more frequently in the latter cases (→ Article 15).

The BMUB 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” and the “Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency” as well as for the information exchange according to bilateral agreements for radiological emergencies.

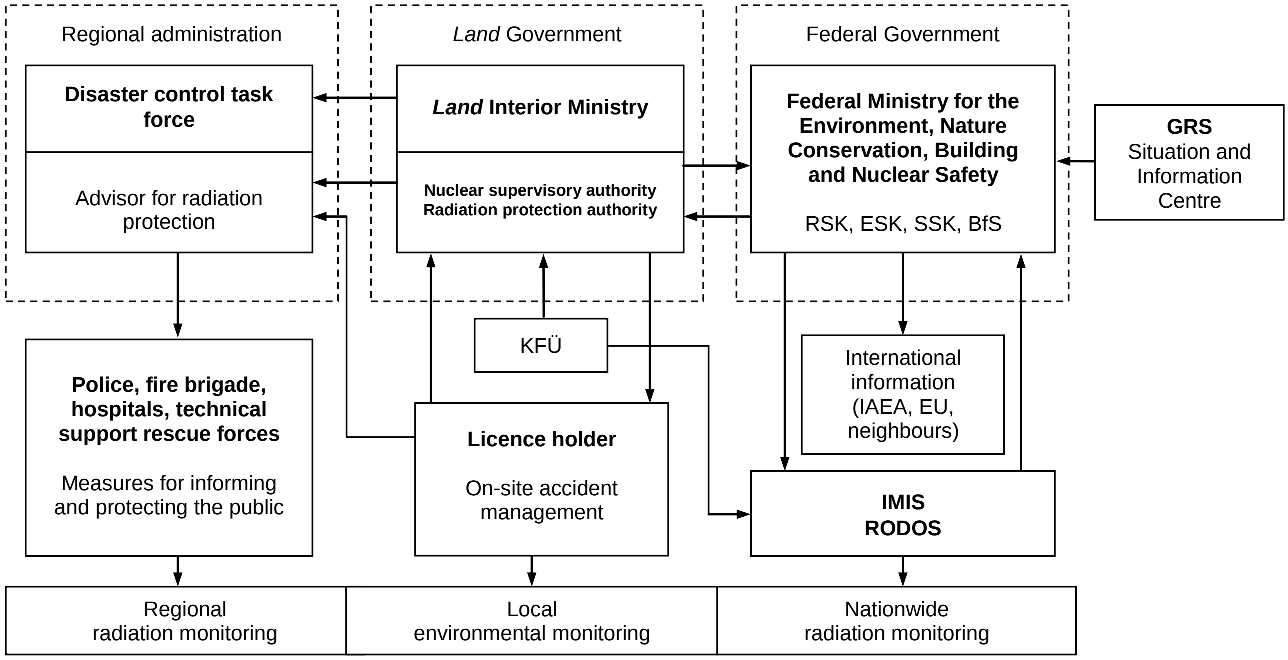


Figure 16-2 Emergency preparedness organisation

Emergency plans and alerts

The alarm regulation of the plant operator includes the regulations on alerting in emergencies. It is part of the BHB and belongs to the safety specifications. In this respect, RSK and SSK recommended “Criteria for the alert of emergency response authorities by the operators of nuclear plants” [4-2]. These make a distinction between the two alert stages “early warning” and “emergency alert”.

An early warning is given if, in the case of an event in a nuclear installation, there has so far been no or – compared with the actuation criteria for an emergency alert – only little effect on the environment but if it cannot be excluded due to the condition of the installation that other effects may occur that meet the actuation criteria for an emergency alert.

An emergency alert is triggered if a dangerous release of radioactive materials into the environment has been detected or is impending in an accident at a nuclear installation.

The licence holder's alarm regulations contain the relevant plant-specific emission and immission criteria as well as technical criteria for an early warning and emergency alert. If these are reached, the licence holder will alert the disaster control authorities, indicating the corresponding stage of alert. Here, the technical criteria, e.g. very high temperature of low RPV level, are of special relevance as they are early indicators of a violation of protection goals and require early warning.

To cope with emergencies, the licence holder establishes a crisis management team. The individual organisational regulations are described in a separate document, the NHB (→ Article 19 (iv)). Specifications regarding the content and structure of the NHB are compiled KTA safety standard 1203 (→ Article 7 (2i)). In their entirety, the regulations mentioned, especially the alarm regulations, the NHB, the mitigative emergency manual (→ Article 18 (i)) as well as the training and further qualification programme represent the licence holder's emergency plan, which includes among others

- measures to render the emergency organisation operable,
- criteria for alerting the competent authorities,
- technical measures for the prevention and mitigation of damages,
- measuring programmes for determining the radiological situation,
- measures for efficient communication and cooperation with external parties, such as the competent authorities, and for informing the population.

Assistance is provided by the crisis management team of the plant manufacturer and by the Kerntechnischer Hilfsdienst GmbH (KHG, an organisation jointly installed by the licence holders of all German nuclear installations). The crisis management team of the manufacturer advises the licence holder in technical questions regarding an assessment of the situation and the restoration of a safe condition of the installation, while the KHG with its manipulators and measuring equipment may be employed at the site inside and outside the installation. In addition, there are mutual support agreements between the licence holders of the nuclear installations.

The competent disaster control authorities prepare special disaster control plans for the vicinity of the installations. They continuously update the plans and review them at regular intervals (on principle annually). Primary objective of the planning of disaster control is, in case of an accidental release, to prevent or mitigate direct consequences from the accident on the population. The content of the planning is based on the “Basic Recommendations”. The disaster control plans focus on the interaction of the planning of the disaster control authorities and of measures of the licence holder and on the implementation of the measures for protection of the population. Moreover, the measurements required for determining the situation are also part of the planning.

For initial medical care and decontamination of the population and the deployment personnel affected by a release, emergency care centres are provided. The regulations on the design and operation of these emergency care centres and a list of doctors willing to provide their services in these centres are included in the special disaster control plans. To this end, the SSK recommendations on medical measures in case of radiological accidents and, in particular, on medical procedures in case of accidents in nuclear installations are available.

Serving as a technical decision basis for the disaster control measures and for precautionary radiation protection are the strategies of measures and the reference levels defined in the “Compendium of Measures” (Compendium of Measures to Reduce Radiation Exposure Following Events with not Insignificant Radiological Consequences (Catalogue of Countermeasures), Volumes 1 and 2)” [4-3], in which the SSK recommendations of the “Basic Radiological Principles” [4-12] and the maximum permitted levels of the EU regarding the radioactive contamination of foodstuffs and of feedstuffs are considered. If necessary, disaster control measures are also implemented by the disaster control authorities outside the planning area.

An important aspect of planning is the information transfer between the authorities and, in particular, the alerting of the authorities by the licence holder. In this respect, RSK and SSK recommended “Criteria for alerting the disaster control authority by the licence holder of a nuclear installation”. According to these criteria, the licence holder defines plant-specific emission and immission criteria and technical criteria in the alarm regulation for an early warning or an emergency alert which, when reached, require the alerting of the disaster control authorities, specifying the respective alert level. In addition, alerting the disaster control authorities is also possible by the responsible nuclear licensing and supervisory authority.

For nuclear installations abroad that may require disaster control measures on German territory due to their proximity to the border, special disaster control planning is performed in the same way and in agreement with the neighbouring countries concerned.

Situation assessment

The assessment of the situation is performed at a radiological situation centre with the information available about the plant state, meteorological situation, and the emission and immission situation. At first, it is based on automatic measurements and prognoses, while later on, additional measurement in the surrounding area becomes increasingly important. Due to the lessons learned from the Fukushima nuclear accident, the SSK prepared "*Requirements for the prognosis and estimation source terms in the case of accidents in nuclear power plants*"[33] as part of a recommendation prepared in 2014.

In the pre-release phase, the radiological situation to be expected in the vicinity of the nuclear installation is estimated on the basis of forecast data of the source term, based on PSA and plant parameters, and of the meteorological situation. To do so, the Real-Time Online Decision Support System (RODOS) of the BfS is used in combination, where appropriate, with the remote KFÜ of the *Land* (→ Article 15). Some *Länder* alternatively use their own specific systems. RODOS is able to calculate local and regional consequences of releases as well as the effectiveness of protective actions, thus providing information about the situation and impact assessments to the competent authorities to assist in decision-making. Prognostic data on the source term are provided by the licence holder based on his situation assessment. 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 (Deutscher Wetterdienst – DWD).

In the release phase, the licence holder determines the source term on the basis of systems-layout-related, radiological and meteorological information, and additional data of the KFÜ may also be available. For an assessment of the radiological situation in this phase, there are furthermore data available from local dose rate probes of the KFÜ that are installed in the near-field of the installation, from the IMIS and perhaps also initial data from measuring teams. Here, again, the decision-making support systems described above are applied. As soon as data according to the measurement programmes provided are available (→ Figure 16-3), the situation predicted is checked and adapted to the situation determined by measurements.

In the post-release phase, the measuring and sampling services of the licence holder and of the authorities (by independent measuring organisations) provide data in line with the provisions of the REI for the determination of the radiological situation, supplemented by follow-up measurements carried out by radiation detection teams (deployment forces of the disaster control authorities). The soil contamination in the more distant surroundings of the nuclear installation and the identification of areas with increased dose rates (hot spots) is shown by means of aero-gamma spectrometry. All measuring teams involved are led by the radiological situation centre or work autonomously according to pre-planned routes compiled in special folders.

The development of the wide-range radiological situation in Germany is determined and presented by means of the IMIS, which provides information for decision-making concerning measures of precautionary radiation protection.

The need 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 electronic situation display system ELAN (Elektronische Lagedarstellung). This provides situation information and additional data and information for the competent authorities and the organs and organisations connected to the system through a secured server connection.

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33 SSK recommendation „Prognosis and Estimation of Source Terms in Nuclear Power Plant Accidents", adopted at the 270th SSK meeting on 17/18 July 2014

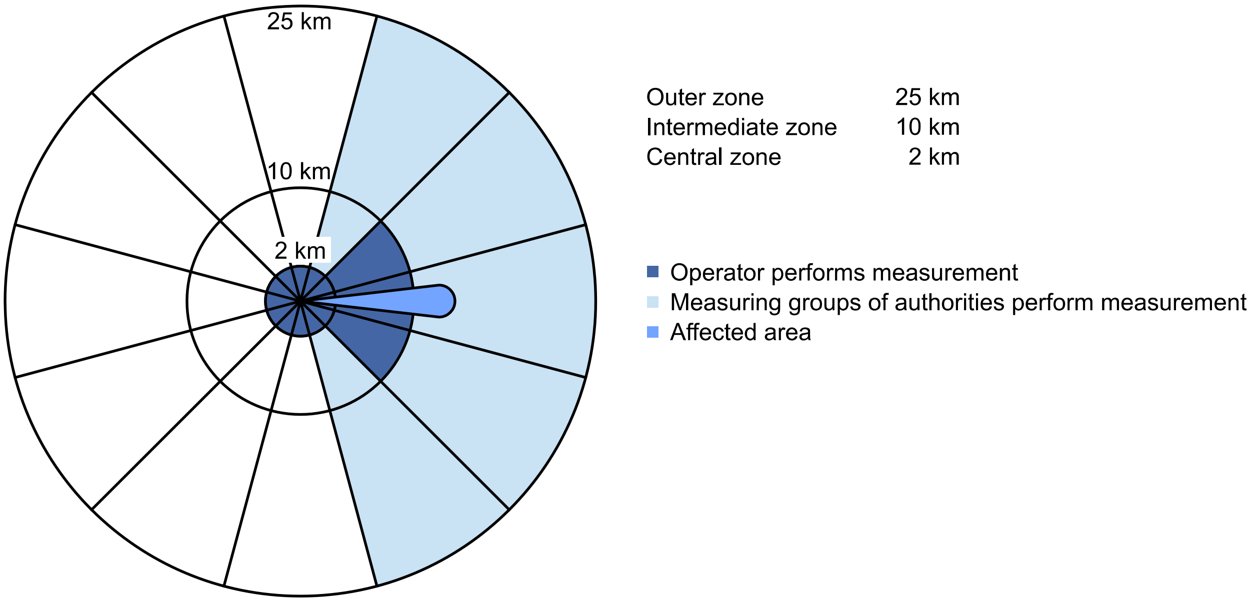

Figure 16-3 Deployment areas of the different measuring and sampling teams

In addition to the computer-based RODOS system, the "Guidance for the expert advisor for radiation protection of disaster control management in case of nuclear emergencies" ("Guidance for the expert advisor for radiation protection") [4-4] and the associated explanatory report as well as the "Compendium of Measures" are available as aids to assess the situation.

The "Guidance for the expert advisor for radiation protection" aims especially at the situation assessment within the framework of disaster control and is available as a computer-based version.

In addition to the disaster control measures, the "Compendium of Measures" also deals with preventive health protection and here especially with measures in the area of agriculture.

Off-site measures

Criteria for protective actions

For the determination of criteria and the decision on measures of disaster control, the following objectives apply:

- Severe deterministic effects shall be avoided by measures for limiting 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 SSK recommendation "Basic Radiological Principles" explains, in particular, the intervention reference levels (as pre-defined planning values) for consideration of the implementation of appropriate disaster control measures. 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. Recommendations from Publications 103 and 109 of the ICRP (International Commission on Radiological Protection) as well as the "*Basic Safety Standards*"[34] of the IAEA,

34 „Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards", IAEA Safety Standards Series No. GSR Part 3, 2014

Council Directive 2013/59/EURATOM and lessons learned from the Fukushima nuclear accident have been taken into account in these recommendations. For a rapid execution of concrete protective actions in the early phase of a release event that is either impending or has already occurred, intervention reference levels are applied used that guarantee compliance with the reference level of the remaining dose in the first year. This reference value of the remaining dose in the first year is essential for decisions about a “temporary or longer-term resettlement”.

Table 16-2 contains the intervention reference levels for protective actions specified in the SSK recommendation “Radiological Bases”, which are derived for a postulated permanent stay outside of an undressed individual. Other criteria referred to within the framework of precautionary radiation protection are in particular the maximum permissible levels of the EU for activity concentrations in foodstuffs.

Table 16-2 Intervention reference levels for protective actions

Protective action	Intervention reference levels		
	Committed equivalent dose (thyroid)	Effective does	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 individuals aged 18 to 45		Committed equivalent dose (thyroid) 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

The revised “Basic Radiological Principles” no longer specify any intervention reference levels for the protective actions “Temporary and long-term resettlement”. Such far-reaching actions with little urgency are only to be decided upon on a much better founded basis once the established radiological situation has been appraised. In such a case, the reference value of the remaining effective dose in the first year after the accident is applied as a criterion.

Specifications on radiation protection of the forces deployed in case of an event as plant personnel, safety and rescue personnel (e.g. police, fire brigade, ambulance staff, doctors) or for specific work (e.g. measurements, transports, repairs, construction work) are included in the StrlSchV and the SSK recommendation “Basic Radiological Principles” (→ Table 15-1). These are considered in the relevant fire service, police service and regulations.

Protective actions in the area affected for averting danger

Off-site emergency planning refers to the preparation and performance of measures for protecting the population 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 potassium iodine tablets (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). For this purpose, the intervention reference levels specified in Table 16-2 are to be applied.

During the review period, the SSK recommendation “Planning areas for emergency response near nuclear power plants” was issued, recommending a review of the planning areas. To do so, the delineation given for the individual zones has to be adapted to the respective local conditions.

Within the central zone, whose radius was extended from 2 km to 5 km, it is in particular the measures “sheltering” distributing and “taking iodine tablets” as well as “evacuation” that have to be planned in advance. In the central zone, all measures have to be prepared independent of the dispersion direction of radioactive materials in such a way that they can be implemented as early as possible before an accidental release takes place. The evacuation of the entire population and the distribution of iodine tablets are therefore to be concluded within about 6 hours after the alert.

Within the intermediate zone, whose radius was extended from 10 km to 20 km, the same measures as in the central zone have to be planned in advance; these, however, are carried out in dependence of the predicted or established direction of dispersion of the radioactive materials if sufficient information is available to assess the radiological situation. Here, an evacuation has to be planned such that it can be concluded within 24 hours. Iodine tablets are to be distributed within 12 hours.

The radius of the outer zone was also extended from 25 km to 100 km. Apart from measuring programmes for determining the radiological situation in order to establish the need for further action, the measures “sheltering”, the distribution of iodine tablets and the warning of the population not to consume recently harvested foodstuffs has to be prepared. Measures in the outer zone are generally carried out in dependence of the dispersion direction of certain radioactive materials that has either been predicted or established by measurements.

Moreover, the supply of the iodine tablets for children and young people under the age of 18 as well as for pregnant women has to be prepared for the entire German territory. The transition to the enlarged planning areas is currently implemented by the *Länder* and has not yet been concluded.

Instruction leaflets for informing the population about how to use iodine tablets are contained in the SSK recommendation “Basic Radiological Principles”. The SSK recommends above all doctors and chemists in potential distribution areas to stock up with iodine instruction leaflets and information about iodine saturation to be able to advise patients in advance on how to behave individually in case an event occurs.

There is furthermore comprehensive information available to the population in connection with the intake of iodine tablets, to be found at the internet address www.jodblockade.de.

In the event of fast-developing events, the specifications provide for a short-term instigation of measures for the protection of the population (warning the population, sheltering, taking of iodine tablets) in the area of the central zone.

In addition to these measures, to prevent incorporation doses by ingestion of recently harvested foodstuffs, a precautionary warning against the consumption of such foodstuffs will be issued. This precautionary measure will be adapted to the current situation as soon as corresponding data from measurements are available. Beyond these protective actions, the “Basic Recommendations” specify and operationalise a list of further measures to be considered in the planning:

- Warning and informing the population
- Controlling, regulating and restricting road traffic
- Establishment and operation of emergency care centres

- Decontamination and medical care of the deployment personnel affected
- Initiating traffic restrictions for rail, waterway and, where required, air traffic
- Informing the water catchment and distribution bodies
- Closing contaminated water catchment points
- Warning the population 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, culling and disposal of heavily contaminated animals
- Decontaminating traffic routes, houses, equipment and vehicles
- Banning the circulation of contaminated foodstuffs and feedstuffs.

Protective measures of precautionary radiation protection for risk minimisation

Measures of precautionary radiation protection serve to reduce the radiation exposure of the population even in those areas where disaster control measures are not justified.

The “Compendium of Measures” developed for this purpose deals i.a. with measures of precautionary radiation protection in the form of recommendations for the population on how to behave and a large number of measures in the area of agriculture to prevent or reduce contamination of agricultural products and agricultural areas. It documents i.a. guide values and reference levels for decision-making. 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, guided by the EU limits for activity in foodstuffs. In addition, the compendium contains information and measures regarding disposal as well as concretisations of the decision-making philosophies and of the assessment of the acceptance of measures in the agricultural area. For example, it has to be considered when planning these measures that the use or the purchase of contaminated agricultural products will be limited for acceptance reasons by the consumer and that disposal will therefore be of more importance than processing.

Other measures of precautionary radiation protection taken into consideration also include temporary and long-term resettlements (→ Table 16-1).

On-site measures

Procedures to be taken by the licence holders of nuclear installations in case of anticipated operational occurrences, incidents and accidents are described in Article 19 (iv). Measures to reduce the probability of accidents involving severe fuel damage (preventive accident management measures) or measures to mitigate the consequences of accidents involving severe fuel damage (mitigative accident management measures) were implemented during the construction of the nuclear installations or were carried out as upgrades of existing nuclear installations. They are dealt with in Article 14 (i) and Article 18 (i).

Exercises

In order to be able to perform the protective actions required in the case of an event effectively, great importance is attached to the on-site and off-site training of deployment personnel.

Exercises conducted by the licence holder of the nuclear installation

The measures provided by the licence holder are exercised, reviewed and developed further by means of exercises performed at regular intervals. Exercises involving all organisational units involved in the licence holder's emergency organisation are generally performed once a year per nuclear installation in accordance with to the “General recommendations for the planning of emergency protection measures by the nuclear power plant operators”.

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 great detail. Typical exercise scenarios are events involving a loss of coolant, external hazards (earthquake, flood, aircraft crash, etc.), ATWS (Anticipated Transients Without Scram) events and station blackout events. In order to simulate beyond-design-basis 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. In addition, events in the field of physical protection are also included in the licence holder's exercise programme. The exercises are carried out in the plants as realistically as possible, with power plant simulators also increasingly used.

The annual exercises are generally limited to the site of the nuclear installations. At larger intervals, the interaction between the manufacturer's emergency response team, the Kerntechnischer Hilfsdienst and the authorities responsible for off-site emergency planning is practised.

The competent authorities are informed about on-site exercises and often participate, frequently as observers on the spot. 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 inspections, for example selected focal activities by the nuclear licensing and supervisory authorities at the site. On the part of the licence holders, exercises are presented and discussed within the scope of the exchange of experiences and feedback, e.g. on VGB Working Panels. Exercises carried out by other nuclear installations at other sites are also observed.

In addition to exercises performed with participation of the nuclear licensing and supervisory authority and the authorised experts, internal accident management exercises including the interfaces with disaster control are also carried out. Among other things, exercises

- on fire protection,
- on availability,
- on plant security and physical protection (other third-party intervention),
- on a beyond-design-basis accident during shutdown,
- of the crisis management team and
- of the medical and rescue service

were carried out. Some of these exercises took place on simulators, also including the situation centre and the KFÜ of the *Land*.

Exercise reports are prepared on the course of the on-site exercises and essential lessons learned are included in the emergency planning. During training measures, the personnel receive a feedback. The documentation on emergency response is regularly reviewed with regard to completeness and correctness.

Exercises conducted by the authorities at national level

The disaster control authorities at *Länder* level and at regional level regularly perform large-scale disaster control exercises at the sites of nuclear installations, albeit at intervals of several years due to the considerable effort and expenditure required. In addition to the competent authorities and the technical advisory commissions, the licence holder of the installation also participates in the exercises. Usually, the potentially affected population does not take an active part in these exercises. Recent examples of such exercises are the emergency response exercises “Brokdorf 2015” and “Neckarwestheim 2015”.

Objectives of these exercises are i.a. to improve communication and interaction within the different organisations and authorities involved in emergency management and the assurance of effective cooperation in disaster control and precautionary radiation protection. Another objective of the exercises is the practical deployment of forces within the framework of measuring tasks and special support services, such as the trial of temporarily established emergency care centres established for the information about decontamination measures and medical care of the population.

The scenario of the exercises focusing 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, the nature and scope of measures, command and control of the task forces, and the information of the population.

While the focus of the exercises performed so far has been on scenarios with a postulated release of radioactive substances into the environment without considering the actual accident sequence within the installation, there is an increasing tendency to perform site-specific, so-called integrated exercises. In these exercises, the licence holder and the competent authorities of potentially affected *Länder* simulate a plant-specific scenario. The objective of these exercises is the integration of the processes developing in the installations and to thus practice the associated cooperation and communication between licence holder and competent authorities.

In the years 2009 and 2014, command post exercises (CORE 2009 and CORE 2014) were carried out for the emergency organisation of BMUB and BfS during which the comprehensive cooperation of the BMUB command posts with the support of GRS and BfS was at the centre of attention.

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 measuring centre, a management and information system for disaster control data, and an electronic situation display with a corresponding communication concept. On the other hand, the exercises are increasingly geared towards the overall cooperation between the different organisations that are assigned to control an accident. Additionally, informing the population becomes increasingly important as a main focus of the exercises.

Furthermore, at national level, exercises are increasingly conducted relating to radiological events, e.g. in connection with terrorist attacks. At *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.

Participation in exercises at international level

As part of international cooperation and on the basis of bilateral contracts, representatives of authorities from neighbouring countries are actively involved, or participate at least as observers, in exercises concerning nuclear installations near the border.

In 2012 and 2013, for example, a joint emergency exercise consisting of several parts was conducted for the French Cattenom nuclear power plant. In 2013, several German authorities and organisations participated in the Swiss large-scale exercise GNU 2013 in which the emergency response of the Leibstadt nuclear power plant that lies on the Swiss-German border was reviewed. In 2015, a hypothetical severe accident in the Swiss Gösgen nuclear power plant formed the basis of a so-called “total emergency exercise” (GNU 2015). German authorities and organisations were also involved in this exercise.

On principle, BMUB and BfS representatives take part - in line with their respective responsibilities - in the regular exercises of the EU (ECURIE exercises (European Community Urgent Radiological Information Exchange)), the IAEA (CONVEX exercises) and the OECD/NEA (INEX exercises), in which – depending on where the exercise takes place – supporting agencies, other federal ministries and the relevant *Länder* licensing and supervisory authorities also participate.

With a view to a further development and harmonisation of nuclear emergency preparedness regulations at an adequately high international level, representatives of the BMUB and experts working on its behalf participate for Germany in the relevant commissions at the OECD/NEA, the IAEA and the EU as well as in a working group on radiological emergency preparedness (Working Group Emergencies, WGE) of HERCA, the European association of the top regulators in the field of radiation protection.

Regulatory review

The topic "emergency provisions" is an independent area of inspection and comprises i.a. the "control of the preparation, execution and evaluation of emergency exercises carried out by the licence holders". This is regularly reviewed by the nuclear licensing and supervisory authorities.

The nuclear emergency preparedness plans of the *Länder* are continuously adapted to the recommendations of the expert committees (e.g. SSK) by the competent local authorities and governments. In addition, to further optimise the management structure and protective measures, the lessons learned from the regularly held exercises are also taken into account in the planning.

Challenge 5: Emergency preparedness and emergency criteria

As part of the German measures following the Fukushima nuclear accident, amongst others the following recommendations were reviewed and revised:

- SSK recommendation on the basic radiological principles for decisions on measures for the protection of the population against incidents involving releases of radionuclides (268th SSK meeting on 13/14 February 2014)
- Guidelines for emergency protection in the vicinity of nuclear power plants

From the point of view of the regulatory body, the planning of emergency response is to be based not only on the occurrence probability of an accident but also on its potential consequences.

It was found during the course of the review that the planning areas for emergency protection in the vicinity of nuclear installations had to be adapted. The recommendation regarding the extent of the areas is in line with the approach of HERCA/WENRA (Western European Nuclear Regulators Association) from the year 2014.

The SSK recommendation on "Basic Radiological Principles" of 2014 takes up the basic recommendations of the ICRP published in 2007 and covers the following areas:

- Phases of a nuclear accident and exposure pathways,
- health effects of radiation exposure,
- actions to protect the population,
- decision-making process in the event of an incident,
- other radiological emergency situations following a major release of radioactive substances,
- radiological protection for emergency services,
- radiation protection for specific professional groups.

The SSK recommends that the planning areas defined in 2014 should be maintained for as long as there are still fuel assemblies within the nuclear installations, but for no longer than three years after the cessation of power operation at the most. Should the fuel assemblies still be within the nuclear installation after three years, the planning areas should be chosen in accordance with the SSK recommendation on iodine thyroid blocking[35].

At its meeting in April 2014, the standing conference of interior ministers and senators of the *Länder* (IMK) acknowledged the SSK recommendations and the results of the *Länder* committee on the Fukushima nuclear accident. At this meeting it was decided that evacuation measures should be included in the planning of civil protection measures. This also includes the evacuation of larger regions.

Each *Land* is required to make provisions for the evacuation of and accommodation of 1 % of its population. On this basis, accommodation is to be prepared all over Germany for a total of 800,000 evacuees.

The return of evacuees and hence the lifting of the protective measure “evacuation” requires a decision that has to be taken from a point of view regarding society as a whole.

The future implementation of the new Directive 2013/59/EURATOM will influence factors that determine the choice of protective actions (and their lifting). It is hence neither practicable nor expedient to define these factors beforehand.

16 (2) Informing the population and neighbouring countries

Informing the population

The essential contents of the information of the population are specified in the StrlSchV. Here, a distinction is made between information to be issued to the population in advance as preparation for a radiological emergency and the relevant information in case of a concrete emergency.

The most important issues about which the population 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 population and the environment, including planned rescue and protection measures,
- information on how the affected individuals will be alerted and how they will be continually updated on the development of the situation,
- information on how the affected individuals should behave and what they should do.

This information is realised by means of a brochure which is posted to the population living in the vicinity of a nuclear installation in coordination with the disaster control authorities. Some brochures are also available on the websites of the licence holders and the disaster control authorities.

In case of a safety-relevant event in a nuclear installation leading to a radiological emergency in the surrounding area, the competent authorities inform the potentially affected population without any delay according to § 51 para. 2 StrlSchV and give advice on how to behave, including detailed

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35 SSK recommendation “Planning iodine thyroid blocking in the vicinity of decommissioned nuclear power plants”, adopted at the 269th SSK meeting on 10 April 2014

specifications on health protection measures to be taken. The information to be given to the population concerns 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,
- naming of the authorities in charge of disaster control.

For example, in case of a pre-alarm level (early warning), the population has to be given the following information and instructions:

- call to turn on radio and television
- preparatory instructions for certain institutions
- recommendations for professions that are particularly affected.

In the guideline for the information of the public in case of nuclear accidents [4-12] published by the SSK, a suggestion is made 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 is intended to be effective with regard to other *Länder*, too, if necessary.

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 can 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 re-appraised 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 neighbouring states

In the event of an emergency, the measured data acquired by the monitoring programmes and the licence holder's situation assessments will be the basis for reporting in accordance with the "European Community Urgent Radiological Information Exchange Agreement [1F-4.1] and the "Convention on Early Notification of a Nuclear Accident" They also serve as a 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 REI are also used for the reports to the EU in accordance with Article 36 of the EURATOM Treaty [1F-1.1].

Germany has signed bilateral agreements regarding mutual assistance in the case of an emergency with all of its nine neighbouring countries. Moreover, corresponding 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 regional level at nuclear power plant sites near the border between the respective disaster control authorities or organisations for determining the radiological situation.

Other cross-border collaboration activities with neighbouring and other states regarding nuclear safety are addressed in Article 17 (iv).

16 (3) Emergency preparedness of contracting parties without nuclear installations

Not applicable to Germany.

Progress and changes since 2014

During the review period, numerous regulatory documents related to emergency preparedness were newly prepared or amended:

Against the background of the nuclear accident at Fukushima, the BMU requested the SSK in June 2011 to carry out a review of the national technical regulations regarding off-site nuclear emergency preparedness. The *Länder* took part in the corresponding working groups at Federation-*Länder* level. The results of the consultations, which lasted for more than three years, have been considered i.a. in the new and revised regulations:

- SSK recommendation: Further development of emergency response through implementation of the lessons learned from Fukushima, (274th SSK meeting on 19/20 February 2015)
- SSK recommendation: Basic recommendations for emergency protection in the vicinity of nuclear power plants, (274th SSK meeting on 19/20 February 2015)
- SSK recommendation: Basic radiological principles for decisions on measures for the protection of the population against incidents involving releases of radionuclides, (268th SSK meeting on 13/14 February 2014)
- SSK recommendation: Planning areas for emergency response near nuclear power plants, (268th SSK meeting on 13/14 February 2014)
- SSK recommendation: Planning areas for emergency response near decommissioned nuclear power plants, (271st SSK meeting on 20/21 October 2014)
- SSK recommendation: Planning iodine thyroid blocking in the vicinity of decommissioned nuclear power plants, (269th SSK meeting on 10 April 2014)
- SSK recommendation: Prognosis and estimation of source terms in connection with nuclear power plant accidents, (270th SSK meeting on 17/18 July 2014)
- SSK statement: Issues relating to the organisation and operation of emergency care centres, (268th SSK meeting on 13/14 February 2014)
- Basic recommendation on the establishment and operation of emergency care centres
- RSK/SSK basic recommendations: Planning of emergency control measures by the operators of nuclear power plants, (468th RSK meeting on 4 September 2014 and 271st SSK meeting on 21 October 2014)
- RSK/SSK recommendation: Criteria for alerting the disaster control authority by the operators of nuclear installations, (453rd RSK meeting on 13 December 2012 and 260th SSK meeting on 28 February 2013)

The planning areas in particular and the associated measures and radii were revised. As regards nuclear installations that are being decommissioned, the special characteristics that are due to the changed hazard potential were adequately considered in the consultations.

The SSK's statement on the organisation of emergency care centres was published in 2014, in particular so that the standards concerning the operation of emergency care centres could be harmonised further.

Future activities

Council Directive 2013/59/EURATOM necessitates amongst other things a far-reaching restructuring of the regulations governing emergency response. Within the framework of the implementation of the Directive, the national nuclear regulations affected are currently being fundamentally revised and updated. This also includes the consideration of the insights gained by the SSK from the lessons learned from the Fukushima nuclear accident.

Furthermore, activities are continuing to expand the technical and organisational collaboration to cope with radiological events. This also includes national exercises with participation of other countries, the involvement of external observers, and the performance of international exercises in regions close to the border.

Efforts are undertaken to further improve the closeness to realistic in exercises within the framework of emergency preparedness, e.g. by means of the increased involvement and use of simulators and by integrating plant-specific sequences in exercise scenarios. The lessons learned from these exercises are to be incorporated in the further development of off-site emergency planning. Moreover, an improved and more extensive information exchange in radiological emergency management will offer the possibility to increase interaction of the emergency preparedness systems at national (between Federation and *Länder*) and international level.

In addition, the influence of the decision taken to terminate the peaceful use of nuclear energy on emergency preparedness in Germany also continues to be examined.

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.

17 (i) Site evaluation

Since § 7 para. 1 AtG stipulates that in Germany no further licences shall be granted "for the construction and operation of installations for the fission of nuclear fuel for the commercial generation of electricity", this section on Article 17 is confined to the design requirements of the nuclear installations and the periodic re-assessment of the site characteristics as part of the PSR. For the German nuclear installations, the requirements of national nuclear rules and regulations applicable at that time with regard to external hazards, in particular earthquake, flood, aircraft crash and blast waves were considered in the design. Within the framework of the safety reviews to be carried out every ten years, the national nuclear rules and regulations applicable at the time of the review serve as a basis for the assessments.

Procedures and criteria for site selection

Criteria for the evaluation of sites for nuclear power plants that are to be applied in a uniform manner throughout Germany are described in "Data for the Evaluation of Site Properties for Nuclear Power Plants" [3-12]. These contain essential aspects concerning the suitability of the site regarding regional planning as well as to nature conservation and landscape conservation. With respect to nuclear safety, the following issues have, amongst others, been taken into account:

- Meteorology with regard to atmospheric dispersion conditions
- Hydrology with regard to cooling water supply, the discharge of radioactive substances via the water path and the protection of drinking water supplies
- Distribution of population in the vicinity of the site
- Geological condition of the building ground, including seismological assessments of the site
- Other natural or man-made external hazards (i.a. flood, aircraft crash, blast wave, intrusion of hazardous substances)
- Road transportation infrastructure with regard to site accessibility
- Distance to military installations

Design against man-made and natural external hazards

The requirements for the construction of the German nuclear installations relating to the design and the protective measures against external hazards followed the provisions of the national nuclear rules and regulations applicable at that time. In the cases where the national nuclear rules and regulations did not contain detailed provisions yet, specific requirements were defined in the respective licensing procedure. The steps in developing the requirements are described below. The re-evaluation of nuclear installations relevant in this context is dealt with in Article 17 (iii).

All nuclear installations at sites subject to such hazards were not only designed against natural external hazards, such as wind and snow, but also against flood and earthquake. In this respect, both nuclear safety standards and conventional civil engineering standards were applied. There are also safety requirements depending on the design of the cooling water supply to the emergency core cooling and residual heat removal system of the plant. It was demonstrated for the individual site conditions that the cooling water supply is ensured even under unfavourable conditions, such as low water in the river or failure of a river barrage.

Design against flooding

Since 1982 the requirements for flood protection measures are included in nuclear safety standard KTA 2207 “Flood Protection for Nuclear Power Plants”, revised in the years 1992 and 2004. According to this standard, permanent flood protection measures shall 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 nuclear installations 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 safety-relevant structures were sealed for water tightness and built with waterproof concrete. Furthermore, openings (e.g. doors) are located above the level of the highest expected flood. In some cases, the flood protection concept also includes dikes. If these permanent protective measures should not be sufficient, mobile barriers are available to close openings.

Design against earthquake

Since 1990, the design against earthquakes has been based on a design basis earthquake (formerly “safe shutdown earthquake”) in accordance with safety standard KTA 2201.1 “Design of Nuclear Power Plants against Seismic Events; Part 1: Principles”. The so-called operating basis earthquake, formerly to be considered additionally according to the previous version of 1975, was replaced by an “inspection level”, beyond which the plant condition is to be checked. Since entry into force of the latest version of KTA 2201.1 in November 2011, the design basis earthquake is determined on the basis of deterministic and probabilistic analyses (according to the earlier versions of KTA 2201.1, it was determined purely deterministically). For both methods, wider surroundings of the site (with a radius of at least 200 km) have to be considered. The deterministic determination of the design basis earthquake is to be based on an earthquake with the maximum seismic impact assumed for the site – taking into account events that have occurred in the past – that can be expected according to scientific knowledge. The probabilistic determination of the parameters of the design basis earthquake has to take an exceedance probability of 10-5/a (median) into account. The design basis earthquake will then be conclusively defined taking into account the results of both analyses. Depending on the site, the intensity of the design basis earthquake lies between VI (minimum design for sites with low seismic risk) and a maximum of VIII (MSK scale).

For nuclear installations of older construction lines no longer in power operation, the seismic qualification of structures, systems and components was partly based on simplified (quasi-static) methods which delivered the basic values for the corresponding design specifications. Within the framework of PSRs, dynamic analysis methods like the ones used in the design of more recent nuclear installations were applied additionally.

Protection against aircraft crash

Protection against aircraft crash refers to the accidental crash of an aircraft on safety-relevant areas of a nuclear installation. The protective measures were implemented against the background of the increasing number of nuclear installations 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 per nuclear installation) 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 impacts of a crash of a fast-flying military aircraft, which were used for the design of protective measures for the nuclear installations built in the following years for further risk minimisation. The requirements relating to the protection against aircraft crash included in the “Safety Requirements for Nuclear Power Plants” are based on the recommendations of the RSK of 1981. As load assumption, a site-independent impact load-time diagram corresponding to the impact of a fast-flying military aircraft of the “Phantom” type (mass 20 000 kg, speed 215 m/s) on a rigid wall is specified. It was furthermore specified, amongst other things, that the impacts of debris and of kerosene fires as well as the vibrations induced by the impact of the aircraft have to be taken into account in the design. However, since the late 1980s, the crash rate of fast-flying military aircraft has decreased significantly so that the crash frequency today can be assumed to be smaller by about two orders of magnitude.

For older construction lines no longer in power operation, protection by system design against the consequences of an aircraft crash was improved by additional auxiliary emergency systems physically separated from the actual reactor building. The second-level emergency systems can ensure compliance with the protection goals (“reactivity control”, “fuel cooling” and “confinement of radioactive material” (→ Article 19 (iv)) even if important plant components are destroyed due to external hazards. The spatial arrangement of the buildings ensures that the safety systems and equipment located in the central reactor area and in the second-level emergency systems do not become inoperative due to the postulated events at the same time. The scope of protection of these nuclear installations 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 have been improved.

For the newer construction lines, the design against aircraft crash also covered, aside from the reactor building, further buildings with systems serving the control of this hazard (e.g. the emergency feedwater building in newer PWRs). Furthermore, protective measures were taken into account for the vibrations in internals and components induced in the event of an aircraft crash, e.g. by uncoupling the ceilings and inner walls from the outer wall or by a special design.

In addition to the impact load-time diagram as load assumption, the “Safety Requirements for Nuclear Power Plants” require considering the following issues:

- vibrations induced by the impact of an aircraft,
- kerosene fires at the plant site,
- kerosene explosions outside of buildings,
- fire or explosion of kerosene having penetrated into buildings,
- intrusion of combustion products into ventilation systems, and
- protection against the impact of debris

Components and systems containing high activities of radioactive substances (e.g. ion exchangers of the coolant purification system) are to be protected separately against the impacts of an aircraft crash to prevent any release of radioactive materials into the environment.

<u>Protection against blast waves</u>

The requirements for protecting nuclear installations against pressure waves from chemical reactions in case of an accident outside the installation were developed in the 1970s due to the specific situation of sites located on rivers with ship traffic and transport of explosive goods. The protective measures are based on the assumption of a maximum pressure of 0.45 bar at the site and that a certain safety distance is kept to potential blast or release locations (e.g. transport routes, industrial plants) a certain safe distance from potential explosion places or release locations (e.g. transport routes, industrial plants) is complied with. They are regulated in detail in the guideline for the protection of nuclear power plants against pressure waves from chemical reactions by means of the design of nuclear power plants with regard to strength and induced vibrations and by means of the adherence to safety distances [3-6] and have been applied since its publication independently of the individual site.

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 planned project on the public, on traffic routes, 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 (2ii)). Furthermore, investigations were carried out as to whether public interests oppose the selection of the site. As part of the nuclear licensing procedure, the respective competent authorities also checked compliance with the requirements regarding water rights, immission control and nature conservation. The construction permits and operating licences of the German nuclear power plants have all been granted before Directive 2011/92/EU of the European Parliament and the Council on the assessment of the effects of certain public and private projects on the environment (EIA Directive) [1F-1.15] entered into force. Assessments of environmental impacts were exclusively performed according to national law.

In case of nuclear licensing procedures within the scope of essential modifications of the installation, the AtG requires to also assess the environmental impacts according to the UVPG.

17 (ii) Evaluation of the likely impacts of the nuclear installation on the environment

With regard to the impacts that an operating nuclear installation 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 normal operation of the installation 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 must not exceed the limits specified in the nuclear licensing procedure. Here, the regulations under water law prescribe tighter limits with regard to heating of river water than the safety requirements. If, due to extreme weather conditions, it is foreseeable that the permissible temperature rise would be exceeded, the respective nuclear installation must reduce its power according to the provisions laid down in the BHB or it must possibly be shut down.

A separate licensing procedure under water law is required for the utilisation of water and the discharge of cooling water and waste water, which is conducted in coordination with the nuclear licensing procedure.

Furthermore, impacts of the installation or parts thereof on the environment (e.g. air, noise, light) have to be considered according to the Federal Immission Control Act (BImSchG) and the related ordinances. To this end, corresponding licences were included in the nuclear licence when the installation was built (§ 8 AtG). Subsequent modifications of the plant or amendments to the BImSchG require appropriate modification and amendment procedures. This concerns e.g. the auxiliary boiler plant, which is conventionally fuelled in most cases, and transformers > 220 kV that are not surrounded by a building structure. If the changes also have an impact on nuclear safety, the nuclear licensing and supervisory authority also has to be involved, otherwise, it is merely to be informed.

Radiological impacts during normal operation of the nuclear installation and design basis accidents

The StrlSchV specifies dose limits and planning levels for the radiation exposure of the general public to be adhered to during specified normal operation and design basis accidents. These are dealt with in Article 15.

Implementation of the requirements in the nuclear licensing procedure

The nuclear licensing procedure (→ Article 7) is regulated in the AtVfV. According to § 15 para. 2, sentence 1 AtVfV, the competent nuclear licensing and supervisory authority can only issue a licence for a nuclear installation if the licensing requirements are fulfilled or if their fulfilment can be ensured by ancillary provisions. The licensing requirements include the requirements regarding the conventional and radiological impacts of the nuclear installation on the environment described in this article. The nuclear licensing and supervisory authority has to verify fulfilment of these requirements as part of the nuclear licensing procedure. It is ensured by provisions of the AtVfV that the nuclear licensing and supervisory authority will carry out this review and will take it into account in its decision. In this context, § 14a AtVfV is of special importance.

§ 14a para. 1 AtVfV obligates the nuclear licensing and supervisory authority in projects requiring an environmental impact assessment – like e.g. the construction or any essential modification of a nuclear installation – to prepare a summarised presentation prior to licensing. It includes the impacts of the project on the environment, i.e. on humans, including human health, animals, plants and biological diversity, soil, water, air, climate and landscape, etc., that are relevant for the decision on the licence application. This presentation is based on the documents submitted by the applicant, various official statements, the results of the authority's own official studies, and comments and objections by third parties.

§ 14a para. 2, sentence 1 AtVfV stipulates that the nuclear licensing and supervisory authority has to assess the impacts of the project on the environment on the basis of the summarised presentation in line with legal and administrative provisions that are relevant for its decision. According to § 14a para. 2, sentence 4 AtVfV, the nuclear licensing and supervisory authority has to consider the assessment it has made or the overall assessment in the decision about the application in accordance with the applicable legal provisions.

17 (iii) Re-assessment of the site-specific conditions

Measures for re-assessment

Article 17 (i) describes the design of German nuclear installations against external hazards. The safety reviews which are to be performed every ten years (→ Article 14 (i)) also include a re-evaluation of the protective measures against external hazards, taking into account any advancement in the state of knowledge. As a result of these reviews, measures have been taken or planned as far as necessary.

The “Safety Requirements for Nuclear Power Plants” serve as a measure for assessing the protection against internal and external hazards as well as against human-induced external hazards (in particular Annex 3).

Section 2.4 (1) of the “Safety Requirements for Nuclear Power Plants” requires that all equipment that is necessary for shutting the reactor down safely, for maintaining it in shutdown condition, for removing the residual heat or for preventing a release of radioactive materials shall be designed such and be able to be maintained in such a condition that they fulfil their safety-related functions even in the case of internal and external hazards as well as very rare human induced external hazards. In this respect, the following hazards have to be considered in particular:

- Natural external hazards, as far as to be considered site-specifically, such as earthquake, flooding, extreme meteorological conditions (e.g. high or low temperatures of outside air or cooling water, storm, snowfall, icing, lightning stroke) or biological impacts
- Man-made external hazards, such as aircraft crash, plant-external blasts, impact of dangerous substances and other man-made hazards (e.g. impact of flotsam, loss of cooling water due to failure of a river barrage downstream, consequences of shipping accidents)

In the nuclear rules and regulations, accidental aircraft crash, blast wave and the impact of hazardous substances are referred to as very rare human-induced external hazards or man-made hazard conditions. Man-made hazard conditions are controlled by means of specially protected emergency equipment. For these, less stringent redundancy requirements apply than for the systems for accident control (level 3 of the defence-in-depth concept) which have to control the single failure and the simultaneous maintenance case in the event of a hazard-induced impact.

Regulatory assessments and activities

The safety reviews of the nuclear installations that are to be or have been submitted according to the AtG are reviewed with the support of expert organisations, using the current guidelines of the competent nuclear supervisory authority. In response to the nuclear accident at Fukushima, additional reviews were carried out as part of the RSK safety reviews and the EU stress tests.

17 (iv) Consultations with neighbouring countries

International agreements and European law

Germany is a contracting party to the “Convention on Environmental Impact Assessment in a Transboundary Context” (Espoo Convention) [1E-1.1]. At EU level, the provisions of the Espoo Convention are implemented by the EIA Directive. These international and European obligations for cross-border participation have been implemented, in particular, through an amendment of the AtVfV. In particular, the authorities of neighbouring countries will be involved in the nuclear licensing procedure if a project could have significant impacts in another state.

Moreover, there is also another tool for assessing possible impacts of projects on neighbouring countries: In accordance with Article 37 of the EURATOM Treaty, the European Commission will be informed of any plan for the discharge of radioactive materials in whatever forms. For this purpose, general information on the site and the essential characteristics of the nuclear installation are submitted, at least six months before the competent authority issues a licence permit for the discharge in question. This serves to establish the possible impacts in other member countries. After a hearing with a group of experts, the Commission comments on the project.

Bilateral agreements with neighbouring countries

In addition to the international instruments described above, from a very early stage, Germany took up cross-border information exchange with its neighbouring countries in connection with nuclear safety and radiation protection.

Currently, there are bilateral agreements in force with seven of the nine neighbouring countries of Germany (the Netherlands, France, Switzerland, Austria, the Czech Republic, Denmark and Poland) on the intergovernmental exchange of information on nuclear installations built in the border regions. An agreement with Belgium is intended.

Joint commissions for regular consultations on questions of reactor safety and radiation protection have been established with the Netherlands, France, Switzerland, Austria and the Czech Republic. The information exchange on nuclear installations in border regions concerns

- technical modifications or other modifications of nuclear installations in border regions 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 for Nuclear Power Plants” and, in particular, also with regard to emergency control measures during design extension conditions.

Overall, the cross-border cooperation enables the neighbouring countries to assess the impacts nuclear installations in border regions will have on the safety of their own country. The agreements on information exchange and mutual assistance in the case of emergencies with neighbouring and other countries and further agreements with other countries as well as with the IAEA and the EU are dealt with in Article 16 (2).

Implementation of the “Vienna Declaration on Nuclear Safety”

The safety reviews of the nuclear installations described in Article 14 (i), that are to be carried out every ten years, also include a re-evaluation of the impact of the site on the safety of the nuclear installations (→ Article 17 (iii)). In addition, an unscheduled special review of the impact of site conditions on safety was carried out for all nuclear installations as part of the EU stress tests after the nuclear accident at Fukushima. The review showed, among other things,

- that for all sites, there are safety margins to the design requirements for hazards from earthquakes due to the conservative design and the seismic activity at the sites, and
- that the protection concept of all nuclear installations in Germany against flooding beyond the design event, i.e. in case of a flood with an exceedance probability of 10-4 1/a, contains additional safety margins.

The nuclear licensing and supervisory authorities of the countries confirmed that the reports of the licence holders are in compliance with the EU stress test requirements.

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

According to § 7 para. 2 AtG, precautions shall be taken to prevent damage resulting from the erection and operation of the nuclear installations. For this purpose, the state of the art in science and technology is defined as the benchmark for granting a licence. The "Safety Requirements for Nuclear Power Plants" require the following: "In order to meet the radiological safety objectives, the radioactive materials present in the nuclear power plant shall be multiple confined by technical barriers and/or retention functions, and their radiation shall be sufficiently shielded. The effectiveness of the barriers and retention functions shall be ensured by the fulfilment of fundamental safety functions. A defence-in-depth concept shall be realised that ensures the fulfilment of the fundamental safety functions and the preservation of the barriers and retention functions on several consecutive levels of defence as well as in the case of any internal and external hazards." (Section 2 (1)).

This is concretised by requirements in terms of a concept of the different levels of defence, a concept of multi-level confinement of the radioactive inventory (barrier concept), a concept of main safety functions and a concept of protection against internal and external hazards as well as against very rare human-induced external hazards.

Current status of implementation

The main requirements of the "Safety Requirements for Nuclear Power Plants" had already been taken as a basis for the design of the first construction lines. For planning, implementation and execution of measures and the design, manufacture and operation of equipment at levels of defence 1 to 4, the following principles for the promotion of safety apply:

- well-founded safety margins, depending on the safety significance of the system,
- inherently safe-acting mechanisms,
- use of qualified materials and manufacturing and testing methods,
- maintenance- and test-friendly design of equipment,
- ergonomic design of the workplaces,
- high quality in manufacturing, construction and operation,
- carrying out of in-service inspections,
- monitoring of the state of the installation,
- concept for the detection of operation- and ageing-induced damages, and

- evaluation and safety-related consideration of operating experience.

For safety systems of level of defence 3, the following design principles shall be applied to ensure the necessary reliability:

- redundancy,
- diversity,
- segregation of redundant subsystems,
- physical separation of redundant subsystems,
- safety-oriented system behaviour in case of malfunctions of subsystems or components,
- preference of passive safety features,
- high availability of necessary auxiliary and supply systems, and
- automation (during the first 30 minutes of an accident sequence, manual actions by the shift personnel not required, but possible).

These principles have been realised plant-specifically in all German nuclear installations, as far as technically feasible and reasonable.

The separation of redundancies is not only realised in the area of engineered systems, 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 (e.g. jet forces), flood, fire or in case of external hazards, are precluded. At the component level, the diversity principle is realised, above all, in those areas where the potential for systematic failures (e.g. CCF) is great and highly safety-relevant.

In the following, the levels of defence are described and backfitting measures to strengthen the defence-in-depth concept specified (other backfitting measures are described in Article 14).

Level of defence 1:

The objective of level of defence 1 is to ensure normal operation (undisturbed, specified normal operation) and to avoid abnormal operation.

Level of defence 2:

The objective of level of defence 2 is the control of operational occurrences and the avoidance of abnormal operation. The level of defence is characterised by the undisturbed, specified normal operation.

At the second level of defence, particular importance is attached to the limitation systems that precede the reactor protection system. There are three types of limitation systems that are classified according to task and requirement. In case of anticipated operational occurrences, the limitations shall automatically limit the process variables to defined values in order to increase the availability of the installation (operational limitations) and to maintain initial conditions for the accidents to be considered (limitations of process variables). Furthermore, safety variables are brought back to values at which continuation of specified normal operation is permissible (protective limitations). Operational limitations are instrumentation and control systems with increased reliability which, for the rest, are comparable with the control systems.

The overall objective is to reach a high degree of automation for relief of man from short-term measures and comprehensive preventive measures to counteract the development of anticipated operational 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 objective is to enable man to fulfil his safety task within the overall system in an optimal manner.

Level of defence 3:

The objective of level of defence 3 is the control of design basis accidents and the prevention of multiple failure of engineered safety features safety. For this purpose, highly reliable safety systems and the reactor protection system are used.

Level of defence 4a:

The objective of level of defence 4a is the control of events with postulated failure of the reactor scram system (ATWS).

Level of defence 4b:

The objective of level of defence 4b is the control of events with multiple failure of safety systems to prevent accidents with severe core damage.

Here, preventive measures of accident management (level of defence 4b) are used which are to maintain or restore core cooling and transfer the installation into a safe state.

Level of defence 4c:

Subsection 2.1 (3b) of the “Safety Requirements for Nuclear Power Plants” stipulates that on level of defence 4c “mitigative measures of the internal accident management shall be provided for accidents involving severe fuel assembly damages for the purpose of maintaining – by using all available measures and equipment – the integrity of the containment for as long as possible, excluding or limiting releases of radioactive materials into the environment according to Subsection 2.5 (1), and achieving a long-term controllable plant state.”

The mitigative measures of level of defence 4c are provided in order to practically exclude events that could lead to

- any releases of radioactive materials caused by the early failure of the containment or
- any releases of radioactive materials requiring wide-area and long-lasting measures of off-site emergency preparedness,

or to limit their radiological consequences to such an extent that off-site emergency preparedness measures will only be required to a limited spatial and temporal extent. For the nuclear installations in operation, the practical exclusion of events with early or large releases is proven by the interaction of plant operation, high reliability of the safety system and a comprehensive accident management.

Section 4.4 “Accidents involving severe fuel assembly damages” of the “Safety Requirements for Nuclear Power Plants” stipulates that for event sequences or plant conditions for which no accident management measures have been planned in advance or the implemented accident management measures prove to be ineffective, recommendations for action shall be in place for the emergency team.

In the period of reporting, the HMN was introduced in all German nuclear installations as part of the National Action Plan to supplement existing NHBs. The strategies and procedures contained in these manuals comply with international recommendations on SAMGs.

Improvements in systems engineering carried out during the reporting period on the basis of deterministic and probabilistic assessments

The modifications and improvements of recent years were focused on the feedback of experience due to WLN of GRS, operating experience and the completion of the implementation of the results of the robustness analyses for maintaining the vital functions in case of beyond-design-basis impacts and plant states in response to the results of reviews after the nuclear accident at Fukushima. These backfitting measures comprise numerous individual measures. Some examples are highlighted in the following:

As an example of backfitting measures in the reporting period in connection with experience feedback, systems and measures for the detection and control of open phase conditions have been implemented in the grid connections of the nuclear installations in power operation. These were taken in response to the events in the installations Byron (USA) and Forsmark (Sweden). As from 2013, corresponding requirements have been incorporated in the relevant nuclear rules and regulations (→ Article 8).

In several nuclear installations, the internal flood protection was further optimised. Currently, analyses are conducted on extended flood protection at the PWR annulus due to the Fukushima accident.

Due to the Fukushima accident and the requirements derived from GRS information notice WLN 2012/02, the RSK statements, the “Safety Requirements for Nuclear Power Plants” as well as the National Action Plan and the robustness assessments of the licence holders, measures were developed and implemented to, among other things, ensure energy supply in case of a station blackout (total loss of three-phase current supply) in order to ensure the removal of residual heat from the installation for at least ten hours. These also include extended accident management measures for core and fuel cooling, such as the provision of mobile emergency power generators and the installation of injection points for injection into the reactor coolant system and the spent fuel pool from the outside, which are also operational in case of internal and external hazards (see also the plant-specific overviews in Appendix 6).

Regulatory reviews and monitoring

Design and construction of a nuclear installation according to the national nuclear rules and regulations and the licensing process are described in Article 7. In this context, the internationally accepted design principles, such as redundancy, single failure concept and physical separation are considered. In the licensing procedure it was verified, for example, that the releases of radioactive materials determined for all design basis accidents (events of level of defence 3) under conservative boundary conditions are below the planning values of § 49 StrlSchV.

The procedures applied to backfitting measures or safety-relevant modifications to the plant are the same as those applied to the erection of a nuclear installation (→ Article 7). Here, however, a graded approach is applied that depends on the safety relevance of the planned measure. The procedures specified by the regulatory authorities for modification or backfitting measures are basically the same for all nuclear 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 structures, systems and components and to operating procedures. Not subject to the modification procedure are, for example, the procurement of parts, editing of documentations or modifications to non-qualified components. In order to limit the administrative effort, 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 licensing and supervisory authority of the individual *Land*, modifications of the lowest category can be carried out by the licence holders on their own responsibility. The first category comprises e.g. modifications which result in an increasing activity inventory in the installation due to a reactor power increase.

The lowest category includes e.g. modifications that do not affect the safety level of the installation. In addition to technical modifications and modifications of operational specifications, e.g. organisational modifications are also 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 nuclear licensing procedure.

Expediency and effectiveness of all systems, equipment and measures originally available or backfitted is continuously checked by means of the operating experience gained (→ Articles 14 and 19) and the integrated event analysis including the interaction between man, technology and organisation (→ Articles 19 and 12) also with regard to further optimisation possibilities. Additional regulatory control takes place within the framework of the PSR (→ Article 14).

18 (ii) Qualification and proof of incorporated technologies

Legal and regulatory requirements for the use of technologies proven in operation or sufficiently tested

Section 3 "Technical requirements" of the "Safety Requirements for Nuclear Power Plants" requires the use of qualified materials and of equipment that has been proven by operating experience or has been sufficiently tested.

A quality assurance system according to nuclear safety standard KTA 1401 "General Requirements Regarding Quality Assurance" ensures that the requirements are fulfilled and maintained. The safety standards of the KTA 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 safety relevance of the system or equipment. Details regarding the technical realisation are specified in the regulations and guidelines. The corresponding KTA safety standards are listed in Appendix 5. These are, above all, the standards of KTA series 1400 "Quality assurance", 3200 "Primary and secondary circuits", 3400 "Containment", 3500 "Instrumentation and reactor protection", 3700 "Energy and media supply" and 3900 "Other systems".

Measures for the introduction of proven technologies

Materials and construction

General requirements apply to the qualification of the materials used according to the conventional and national nuclear rules and regulations. The qualification tests largely follow the practice from engineering experience with industrial installations requiring regulatory supervision and from regulations in terms of construction supervision. In the case of nuclear installations, 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 regard to a favourable distribution of stresses and strains and to ease of inspection. As far as specific 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 consider 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 the manufacturing process is carried out for each manufacturer individually and is repeated at specified time intervals. An independent authorised expert participates in manufacturing steps that are important with respect to the qualification of the materials, the manufacturing process and components. The results of the tests are documented and the evaluations of the authorised experts are submitted to the nuclear licensing and supervisory authority.

Active components

For the majority of active components and their operating hardware, the manufacturers and licence holders of the nuclear installations make use of series-produced items for which extensive industrial experience is available. This applies in particular to electrical components and 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 as well as for turbines. Such equipment is used in conventional power producing facilities and in the chemical industry. The same applies to the consumable operating media, such as 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 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 and the results obtained submitted to the nuclear licensing and supervisory authority for review.

Analyses, tests and experimental methods for the qualification of technique applied and new technologies

The suitability and qualification of the technique applied 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 condition, or seismic impacts,
- proof on the basis of verified models,
- proof of the long-term behaviour by artificial accelerated ageing,
- reliability data or service life certificates for 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 (→ Article 19).

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. As a part of the safety culture in the Federal Republic of Germany it has proven effective in such cases that all parties involved look for technical solutions in consensus that go beyond what is necessary in terms of safety but would also bring about long-term improvements. Examples of such cases are

- the replacement of pipes in the main steam and feedwater systems of BWRs both inside and outside of the containment,
- backfitting of diverse pilot valves in the overpressure protection system of BWRs,
- conversion of all PWRs to high-AVT (all volatile treatment) of the secondary-side water chemistry,
- fabrication of weld seams for better testability with ultrasonic procedures either by machining the weld surfaces, or
- rewelding of seams of 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.

Annex 5 of the “Safety Requirements for Nuclear Power Plants” defines detailed requirements for safety demonstrations and documentation. Accordingly, the applicability of the analysis tools for safety-relevant proofs shall be validated.

Regulatory reviews and monitoring

The test programmes are submitted to the competent licensing and supervisory authority and reviewed by the authorised experts consulted (§ 20 AtG). Furthermore, the authorised experts participate in tests and trials, some of them also being conducted at the manufacturer’s. With regard to questions important to safety, the authorised experts consulted carry out own analysis, preferably with independent calculation models.

The authorised expert reviews all aspects subject to the licensing and supervisory procedure as to whether additional requirements could be necessary beyond those specified in the applicable standards and guidelines and proposes them to the competent nuclear licensing and supervisory authority. Decisions are taken by the nuclear licensing and supervisory authority.

18 (iii) Design for reliable, stable and easily manageable plant operation

Overview of the regulatory basis for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface

The basic requirements for the design of nuclear installations, requirements as regards simplicity of system design (ergonomics), physical separation of redundant subsystems as well as accessibility for inspections, maintenance and repairs are laid down in the “Safety Requirements for Nuclear Power Plants”.

High reliability of systems and components has already been achieved during design, construction and manufacturing by adherence to the design principles. These include the use of high-quality materials and comprehensive quality assurance. An optimal maintenance concept ensures high reliability and availability of systems and components for the entire lifetime of the installation. Thus, appropriate design and quality of the systems and equipment of the first level of defence ensures a reliable and undisturbed operation and reduces the probability of occurrence of incidents and accidents.

Section 3 “Technical requirements” of the “Safety Requirements for Nuclear Power Plants” includes requirements for the ergonomic design of the prerequisites for reliable personnel actions. Detailed requirements are defined, among others, in the KTA safety standards. The technical measures as well as provisions in relation to the organisation and implementation of work procedures are stipulated in the safety standards of the KTA series 1200 “General, Administration, Organisation” and 3200 “Primary and Secondary Circuits” (→ Appendix 5).

Personnel qualification

In addition to technical measures, human and organisational measures and their interactions are also of great importance for the safety of the nuclear installations. Therefore, the AtG 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 therein is equally necessary as the fulfilment of the requirements regarding precautions to prevent damage. These requirements must be seen comprehensively and also extend to the economic reliability and appropriateness of the organisation (→ Article 9).

Integrity concept

The concept of basic safety was developed in the late 1970s. It contains detailed provisions with the objective of preventing catastrophic failure of pressure-retaining components due to manufacturing defects. In the national nuclear rules and regulations, this concept is enshrined in the “Safety requirements for Nuclear Power Plants” and in the nuclear safety standards of the KTA.

The basic safety of a 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,
- ensuring application of optimised manufacturing and test technologies,
- knowledge of any possible fault conditions and their evaluation, and
- accounting for the operating medium.

In Germany, the concept of basic safety was further developed to the integrity concept in order to ensure component integrity during operation of light water reactors. Recent developments in this area incorporate, in particular, ageing processes and their control in the overall concept, which puts all aspects of integrity proof 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 “Components of the Reactor Coolant Pressure Boundary of Light Water Reactors; Part 4: In-service Inspections and Operational Monitoring” in the form of a process diagram.

Of particular relevance is the proof of integrity for piping systems with break preclusion. These are to be designed such that during in-service inspections, indication changes or even service-induced cracks must not occur. Until now, the integrity concept has been proven in practice and presents an important contribution in terms of damage precaution. The technical basis for it is nuclear safety standard 3206 “Verification Analysis for Rupture Preclusion for Pressure Retaining Components in Nuclear Power Plants”.

Measures introduced by the licence holders and technical improvements

There were no major changes during the reporting period.

Monitoring and control by the nuclear licensing and supervisory authorities

Prior to performance, the licence holder of a nuclear installation has to submit safety-relevant modifications of the installation or its operation to the nuclear licensing and supervisory authority for licensing or approval within the supervisory procedure (→ Article 18 (i)). The regulatory review is usually performed with the involvement of authorised experts. It is checked whether the requirements of the national nuclear rules and regulations are fulfilled. The review also includes the consideration of findings and knowledge gained from operating experience as well as of human factors and the man-machine interface.

Implementation of the “Vienna Declaration on Nuclear Safety”

As described in the section on Article 6, point 1 of the “Vienna Declaration on Nuclear Safety” cannot be implemented in Germany since, according to § 7 para. 1, sentence 2 AtG, no further licences will be issued for the construction and operation of installations for the fission of nuclear fuel for the commercial generation of electricity.

In Germany, however, the practical exclusion of events with early or large releases is already required for the nuclear installations in operation by the measures described in this article under the heading “Level of defence 4” and is also to be proven by the licence holders of the nuclear installations. The proof can be provided by fulfilling the requirements for the operation of the installation, the high reliability of the safety system and a comprehensive accident management. In this context, comprehensive backfitting measures have already been conducted at the German nuclear installations in the preventive area after the Chernobyl accident (→ Tables 6-2 and 6-3).

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

In Germany, the granting of a licence is regulated, in particular, in § 7 AtG and in the AtVfV. The licences for construction and operation of the eight nuclear installations in Germany still authorised for power operation have been issued in several partial licences. For this purpose, each installation had to submit a safety report and demonstrate compliance with the design and safety requirements of the then applicable national nuclear rules and regulations.

A detailed description of the nuclear licensing processes in Germany is included in Article 7 (2 ii).

Safety analysis

The operating licences of the nuclear installations in Germany are based on the results of a safety analysis and its detailed review by the competent nuclear licensing and supervisory authority of the respective *Land*. Details on how the safety analysis is carried out are described in Article 14 (i).

Commissioning programme

In Germany, the commissioning programmes were generally carried out in four phases:

- <u>Commissioning of the systems</u>:
  During commissioning of the systems, all necessary functional and operational tests were performed to ensure that the individual components and systems were available in proper functioning order.
- <u>Hot functional run, Phase 1:</u>
  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 in order to ensure proper functioning of the installation as a whole. In this phase, functionality was tested without fuel loading of the reactor.

- Hot functional run, Phase 2:
  Hot functional run, Phase 2, was performed to verify the functionality and the safety of the installation as a whole after initial fuel loading of the reactor before starting nuclear operation.
- Tests at zero- and partial-load levels:
  After reaching criticality for the first time, comprehensive tests at zero- and partial-load levels were carried out at each appropriate power stage.

Accompanying control during construction

In parallel to the construction and commissioning of the reactor, manufacturing and installation of safety-relevant systems and components were controlled. For this purpose, compliance of the systems and components with the then existing requirements was verified by the licence holder as well as by the authorised experts consulted by the nuclear licensing and supervisory authority.

Regulatory supervision

The scope of supervision under nuclear law by the competent licensing and supervisory authorities during construction and commissioning of nuclear installations was based on the then applicable safety and design requirements of the national nuclear rules and regulations. Further details are described in Article 7.

19 (ii) Operational limits and conditions of safe operation

Legal and regulatory requirements

According to the requirements of the AtVfV, all safety-relevant data concerning the nuclear installation and its operation were to be submitted with the application documents for an operating licence.

The requirements relating to the BHB and the safety specifications are laid down in safety standard KTA 1201. More detailed requirements for safety specifications are included in the guidelines concerning the requirements for safety specifications for nuclear power plants.

In Germany, all operational and safety-related instructions, operational limits and conditions for the safe operation of an installation are contained in the BHB as safety specifications, including all operational and safety-related regulations and the safety specifications required for safe operation and the control of anticipated operational occurrences and accidents.

The safety specifications of each nuclear installation in Germany are determined plant-specifically. The operational limits are defined for various plant conditions, and it is described what influence it may have on the safe operation of the installation if these limits are exceeded or if the values fall below the specified limits.

The safety specifications are part of the nuclear licensing process and must be submitted by the applicant as a condition for the granting of an operating licence. They are a binding and updated documentation of the permissible framework for the operating mode of an installation in terms of safety.

Specification of limits and conditions

The BHB contains all operational and safety-related instructions, limits and conditions that are required for normal operation of the installation as specified and for the control of anticipated operational occurrences and accidents as well as plant regulations. These apply to all staff working in the nuclear installations.

The safety specifications are included in the BHB and identified as such.

In case of deviations from limits or conditions of the specified range, the measures to be taken are laid down in the BHB. Irrespective of how fast normal operating conditions can be restored, the result is documented and, if the respective criteria are met, is made part of the internal experience feedback as an alarm notice (→ Article 19 (vi)).

Reviews and revision of limits and conditions

During operation of a nuclear installation, modifications to the safety specifications may become necessary, e.g. due to findings from operating experience or other new findings. In this case, these will be reviewed and adapted. Review and adaptation can be done either at the initiative of the licence holder of the nuclear installation or by order of the nuclear licensing and supervisory authority.

In case of modifications to the safety specifications, the shift personnel concerned will be directly informed through meetings or notices. For the maintenance of technical qualification (→ Article 11 (2)), the simulator training courses prescribed for it are also used to specifically practice new procedures where required.

Regulatory supervision

Modifications to safety specifications as part of the BHB are subject to approval by the competent nuclear licensing and supervisory authority. Should the nuclear licensing and supervisory authorities have indications that modifications to the safety specifications could be required it may initiate reviews and enforce necessary modifications.

The competent nuclear supervisory authorities of the *Länder* monitor compliance with the safety specifications. For this purpose, records of the nuclear installations and reports of the licence holders of the nuclear installations are controlled. This is done on the basis of the regulations specified in the individual nuclear licences.

19 (iii) Procedures for operation, maintenance, inspection and testing

Procedures for operation

In addition to technical prerequisites, licensing of a nuclear installation is also based on personnel and organisational prerequisites (→ Article 9). The approved procedures for operation, including maintenance and testing, but also for the management of anticipated operational occurrences and accidents described in Article 19 (iv) determine the organisational and operational structure of the nuclear installations. This structure is laid down in detail in the BHB of the respective nuclear installation.

Safe operation is the responsibility of the plant manager or, in the event of absence, one of the deputies. Quality assurance and radiation protection are separate from the divisions responsible for operation and maintenance and are organised independently.

Other procedures are laid down in the BHB (safety standard KTA 1201), the NHB (safety standard KTA 1203) and the testing manual (safety standard KTA 1202). The safety requirements are included in the respective KTA safety standards referred to in parentheses.

Operating manual (safety standard KTA 1201)

The organisational and operational structure for normal operation of an installation is described in detail and defined in the BHB in accordance with safety standard KTA 1201. In the operative part, it also includes measures for the management of anticipated operational occurrences and accidents. The BHB is kept up to date through a revision service and is subject to the nuclear licensing and supervisory process. In each control room, the current and applicable BHB must be easily accessible to the staff of the control room at any time. In addition, at least one copy is to be kept available in the supplementary control room.

The BHB consists of the following parts:

1. Plant regulations:
   Organisational structure with the right to give instructions, tasks, responsibilities, subordinations, control room and shift regulation, maintenance regulation, radiation protection regulation, guard and access regulation, alarm regulation, fire protection regulation and first aid regulation

2. Plant operation:
   Prerequisites and conditions for all operating phases, safety-relevant limits, testing schedule, criteria for reportable events, instructions for normal and abnormal operation

3. Design basis accidents:
   Symptom-based (protection-goal-based) and event-based handling of accidents during power or shutdown operation, supplementation by incident decision guide and transition to the NHB in case of non-fulfilment of one of the protection goals

4. Systems operation:
   Instructions for operational processes of all systems under specified initial conditions or operating conditions

5. Alarms:
   Alarm signals from failures/malfunctions and hazardous conditions and the corresponding system-related actions initiated automatically or to be triggered manually

6. Annexes:
   Links between the licensing documents and the regulations of the BHB, up-to-date system plans of the installations and further documents relevant to operation (e.g. chemistry handbook)

Emergency manual (safety standard KTA 1203)

The plant-specific NHB includes organisational regulations and measures for beyond-design-basis events. It contains the descriptions of organisation, responsibilities and tasks, instructions, documents and aids for coping with such an event sequence. This is to identify and control beyond-design-basis event sequences at an early stage and to mitigate their potential impacts inside and outside of the installation as far as possible. These are planned measures of accident management and situational measures in the preventive and mitigative area. The transitions from the BHB to the NHB and back again to the BHB are defined and described. The NHB is kept up to date through a revision service and is subject to the nuclear licensing and supervisory process. In each control room, the current and applicable NHB must be easily accessible to the staff of the control room at any time. In addition, at least one copy each is to be kept available in the supplementary control room and at the work locations of the emergency team.

The structure of the NHB is symptom-based. If necessary, event-based measures may be added. The chapters relating to the emergency measures are preferably structured according to the main safety functions and protection goals.

The description of the emergency measures includes the objective of the measure, criteria for the selection of an emergency measure, possible cases of emergency, requirements in terms of systems engineering, staffing needs, task location, auxiliary equipment and time needed, grace times, expected effectiveness, description of the measure and effectiveness control.

Maintenance or modifications

Maintenance consists of measures for maintaining and restoring the specified condition of the installation. Furthermore, the actual state (including in-service inspections) is determined and evaluated. For this purpose, the aspects of quality assurance, plant safety, radiation protection and personal protection are also taken into account.

One part of maintenance is the preventive maintenance through inspections and servicing. Another part is maintenance through repairs. The work steps from planning of the measure and its implementation up to the restoration of operational readiness and documentation are specified.

Since the construction of the nuclear installations (1969-1989), the test and maintenance concepts have been further developed based on new findings from operating experience and results of safety research using deterministic and probabilistic methods.

The requirements for maintenance and modifications are defined in the guideline on maintenance [3-41] and are supplemented by Chapter 5 of safety standard KTA 1402.

Testing manual (safety standard KTA 1202)

The testing manual regulates the frequency and proceeding of the in-service inspections on safety-relevant systems and their components to be conducted by the licence holder of a nuclear installation. It includes general instructions, the testing schedule and corresponding testing instructions for in-service inspections. The testing manual is kept up to date through a revision service and is subject to the nuclear supervisory process.

Furthermore, the testing manual includes descriptions of the proceeding regarding the appointment of external experts, the organisation of the execution and evaluation of tests as well as the rules of conduct regarding compliance with testing instructions, tolerance ranges of the testing intervals, and procedures in case of modifications to the testing manual.

The testing schedule contains a list of all safety-relevant in-service inspections. It covers the test object, the type of test, the scope of the test, the clear designation of the testing instruction, the test interval or the cause of the test as well as the plant condition under which the test is performed.

Regulatory supervision

The competent nuclear licensing and supervisory authority checks within the framework of inspections in the nuclear installations whether the regulations on the organisational structure specified in the BHB are also adhered to in practice. For this purpose, on-site inspections, controls at the control room and controls of organisational processes are conducted. Here, e.g., keeping of the shift log, performance of prescribed walk-throughs or the handling of alarms is checked. In the area of radiation protection, it is checked, e.g., whether dose limits are complied with.

An obligation to review maintenance strategies and measures by the competent nuclear licensing and supervisory authority derives from the “Safety Requirements for Nuclear Power Plants” and the subordinate nuclear rules and regulations (e.g. KTA safety standards, DIN, etc.) whose permanent fulfilment and compliance is subject to review. This is partly laid down in the nuclear licensing documents.

19 (iv) Procedures for responding to operational occurrences and accidents

Legal and regulatory requirements

§ 7 para. 2, subpara. 3 AtG stipulates that the necessary precautions have to be taken in the light of the state of the art in science and technology to prevent damage resulting from the erection and operation of an installation. Radiological requirements for operation, design basis accidents, accidents and radiological emergency situations are included in §§ 49-51 StrlSchV. The non-mandatory guidance instrument “Safety Requirements for Nuclear Power Plants” include further safety-related requirements. Their implementation in the form of plant-specific measures is carried out, among other things, on the basis of safety standard KTA 1201 (BHB), 1202 (testing manual) and 1203 (NHB).

Postulated events: anticipated operational occurrences, design basis accidents and emergencies

In Germany, the following event types are considered in addition to normal operation: anticipated operational occurrences, design basis accidents and emergencies. After the occurrence of an event, the shift personnel controls fulfilment of the main safety functions. These are:

- “control of reactivity” (subcriticality),
- “fuel cooling” (in the reactor pressure vessel and in the spent fuel pool), and
- “confinement of the radioactive material” (maintenance of barrier integrity).

In case of longer lasting event sequences and independently of the approach for taking corrective measures, the main safety functions are repeatedly checked and the approach chosen adjusted if appropriate.

Specific plant parameters are assigned to each protection goal. Should compliance with any of the protection goals be jeopardised or violated, symptom-based procedures are used to bring back the plant parameters into the normal range. This approach is based on observable plant conditions (symptoms) and does not require the identification of the actual event.

For the control of design basis accidents, symptom-based or event-based procedures are available to the shift personnel. By means of the so-called incident decision guide it will be decided which measures are to be taken for the management of design basis accidents.

If an accident or failure (e.g. loss-of-coolant accident, failure of heat removal without loss of coolant, etc.) can be clearly identified and if compliance with the protection goals is not jeopardised or violated, event-based procedures are applied. By means of detailed step-by-step programmes, the installation is brought into a long-term safe condition.

The event-based procedures include the following information (safety standard KTA 1201):

- criteria for identifying the plant state or the event (e.g. accident decision tree),
- naming of the safety-relevant automatic measures,
- naming of the essential measures required for controlling the accident and to be initiated manually by the shift team, and
- details about how to check the effectiveness of the measures with indication of the plant parameters which have to be monitored in particular for staying within permissible limits.

In parallel, it is checked regularly whether the protection goal criteria are still met. Should it be detected that one of the criteria is violated, the event-based procedure is to be discontinued and the symptom-based procedure to be applied.

In case of beyond-design-basis plant states (emergencies, very rare human-induced external hazards), emergency operating procedures and accident management measures are carried out as specified in the NHB.

In addition to the main control room, each German nuclear installation has a supplementary control room for specific beyond-design-basis events which is protected against external hazards. The issue of accessibility of the supplementary control room in case of heavily damaged infrastructure (design extension conditions) has already been implemented before the Fukushima accident in 2011 and the German National Action Plan adopted in response to it.

For all German nuclear installations, it is provided that an emergency organisation and a crisis management team support the measures taken during emergencies organisationally. The crisis management team of the installation concerned is assisted by a crisis management team of the manufacturer of the installation in technical issues. Furthermore, there is the KHG, jointly installed by the licence holders of the nuclear installations to cope with emergencies and eliminate possible consequences (→ Article 16).

In addition to the existing NHB, plant-specific HMNs have meanwhile been introduced at all German nuclear installations for their crisis management teams as part of the National Action Plan after the Fukushima accident. The procedures and strategies contained in these manuals comply with the international recommendations on SAMGs.

Regulatory review

An essential tool of nuclear supervision of the nuclear installations is the handling of events. Reporting of events by the licence holders to the nuclear licensing and supervisory authorities is regulated in the AtSMV. Accordingly, the licence holders of nuclear installations are required to report accidents, incidents and other events which are important in terms of nuclear safety to the nuclear licensing and supervisory authority. An event in a nuclear installation is reportable if it meets the criteria specified in Appendix 1 of the AtSMV (→ Article 19 (vi)).

19 (v) Engineering and technical support

Internal technical support

In accordance with the organisational structure, as implemented at most of the German nuclear installations, the production and operation division which is directly responsible for plant operation is supported in its activities by organisational units, e.g. for engineering, maintenance and surveillance. These organisational units, whose integration into the organisational structure may differ from installation to installation, have well-defined tasks and the necessary technical expertise for their fulfilment:

- Engineering:
  Maintenance and optimisation of the functionality and operational safety of the mechanical, electrical and I&C components and systems. This also includes the planning and surveillance of modification measures.
- Maintenance:
  Planning, control, performance and surveillance of maintenance measures, technical modifications and backfitting measures.

- <u>Surveillance:</u>
  Working out solutions for all technical issues that concern the nuclear installation or its operation in physics, chemistry, radiation protection, environmental protection, fire protection and physical protection.

Apart from this, the licence holders 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

In case of planned modification measures, the licence holders of the nuclear installations often work together with external partners. If further analyses are required for proofs of safety, the licence holders may use the services of third parties.

Regulatory supervision

The supervisory measures of the *Land* authorities concern, besides controlling quality assurance and documentation, extensive on-site inspections to comprehend how safety-significant measures are implemented. The responsibility of the licence holders for the safety of their nuclear installations remains unaffected by this.

For the performance of on-site inspections in the nuclear installations and the clarification and assessment of technical issues, independent expert organisations are consulted (§ 20 AtG). These must have the necessary professional skills and staff capacities. Due to a high inspection frequency, the nuclear licensing and supervisory authorities and their experts obtain highly detailed knowledge about the status of the nuclear installations under supervision.

In addition, the BMUB deals with generic and international safety-relevant issues (projects), for which support is provided by the BfS, the RSK, GRS and, where appropriate, by other expert organisations. These projects are financed by funds from the federal budget.

19 (vi) Reporting of safety-relevant events

Legal and regulatory requirements

According to the AtSMV, the licence holders of nuclear installations are required to report and evaluate events occurring in the nuclear installations (accidents, incidents and other events which are important in terms of nuclear safety).

An obligation of the licence holders to report safety-relevant events to the competent nuclear licensing and supervisory authority of the *Land* was already laid down in the original version of the AtG of 1959. The AtSMV includes reporting criteria for the categorisation of reportable events. Based on these reporting criteria, the licence holders of nuclear installations have to report all safety-relevant events to the competent nuclear licensing and supervisory authority of the *Land* within specified time limits (reporting categories). The reporting criteria consist of a radiological part, which applies to all installations, and of technical parts, which differ from each other according to the various types of nuclear facilities. For the reporting criteria of the AtSMV, separate explanations are in place. The aim of the explanatory notes on the reporting criteria is – in addition to the necessary specification and description of the radiological and plant-specific reporting criteria and the associated precise definition of the reporting threshold – to take into account the experience of the nuclear licensing and supervisory authorities in the enforcement of the AtSMV. Therefore, the explanatory notes are continuously improved and adapted.

A reportable event is to be notified to the nuclear licensing and supervisory authority of the respective *Land* in writing by means of an official reporting form, including a description of the actual event, its causes and effects as well as the remedial measures taken and the measures provided to prevent recurrence. The nuclear licensing and supervisory authority of the *Land* in turn reports the event to the Incident Registration Centre at the BfS as well as to the BMUB and their expert organisation GRS. The reportable events are evaluated by the licence holders, authorities, authorised experts and – in so far as necessary – also by the manufacturers.

The BfS informs all nuclear licensing and supervisory authorities of the *Länder*, the authorised experts involved, the manufacturers and the licence holders of the nuclear installations in quarterly reports and the public in monthly and annual reports about the reportable events in nuclear installation according to the AtSMV. The database of the reportable events at the BfS is accessible to the nuclear licensing and supervisory authorities of the *Länder*, the BMUB and GRS.

The licence holders of the nuclear installations inform the public about all reportable events in their nuclear installations in an appropriate manner. Own staff are informed about reportable events by internal communication.

Reporting categories

Reportable events are assigned to one or several reporting categories by means of the reporting criteria based on an initial engineering assessment of the cause of the event. These are as follows:

- Category S
  Immediate report – reporting deadline: without delay
  Events must be notified to the nuclear licensing and supervisory authority of the *Land* immediately, so that it can initiate investigations or measures within a very short time period if necessary. This also includes events that indicate acute safety deficiencies.
- Category E
  Quick report – reporting deadline: within 24 hours
  These events do not demand any immediate action by the licensing and supervisory authority. For safety reasons, however, the cause is to be identified quickly and, if required, corrective actions are to be taken within a reasonable time period. These are, in general, events that may have a potential but no direct significance in terms of safety.
- Category N
  Normal report – reporting deadline: within five working days by means of a reporting form
  Events with low safety significance. They are evaluated in order to identify potential weak points at an early stage before any larger disturbances.
- Category V
  Prior to commissioning – reporting deadline: within ten working days by means of a reporting form
  Events that occur prior to commissioning of the installation and about which the nuclear licensing and supervisory authority has to be informed with respect to the future safe operation of the installation.

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 levels.

Table 19-1 Number of reportable events per year from nuclear installations for electricity generation according to reporting categories

Year	Number	Reporting categories			INES levels		
		S	E	N	0	1	2
2015	60	0	2	58	60	0	0
2014	67	0	0	67	67	0	0
2013	78	0	1	77	77	1	0
2012	79	0	0	79	79	0	0
2011	103	0	0	103	103	0	0
2010	81	0	4	77	80	1	0
2009	104	0	2	102	104	0	0
2008	92	0	4	88	91	1	0
2007	118	0	4	114	116	2	0
2006	130	0	4	126	129	1	0

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. Figure 19-3 shows the development of the average number of reactor scrams over the last ten years, also indicating their essential causes.

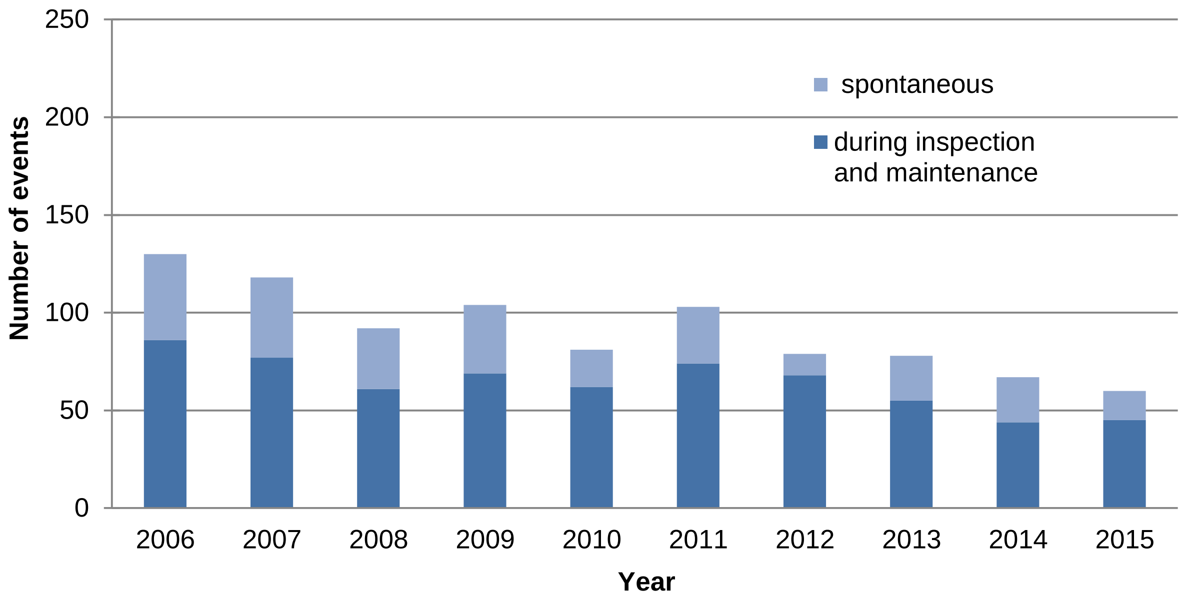

Figure 19-1 Reportable events from nuclear installations for electricity generation according to the kind of occurrence

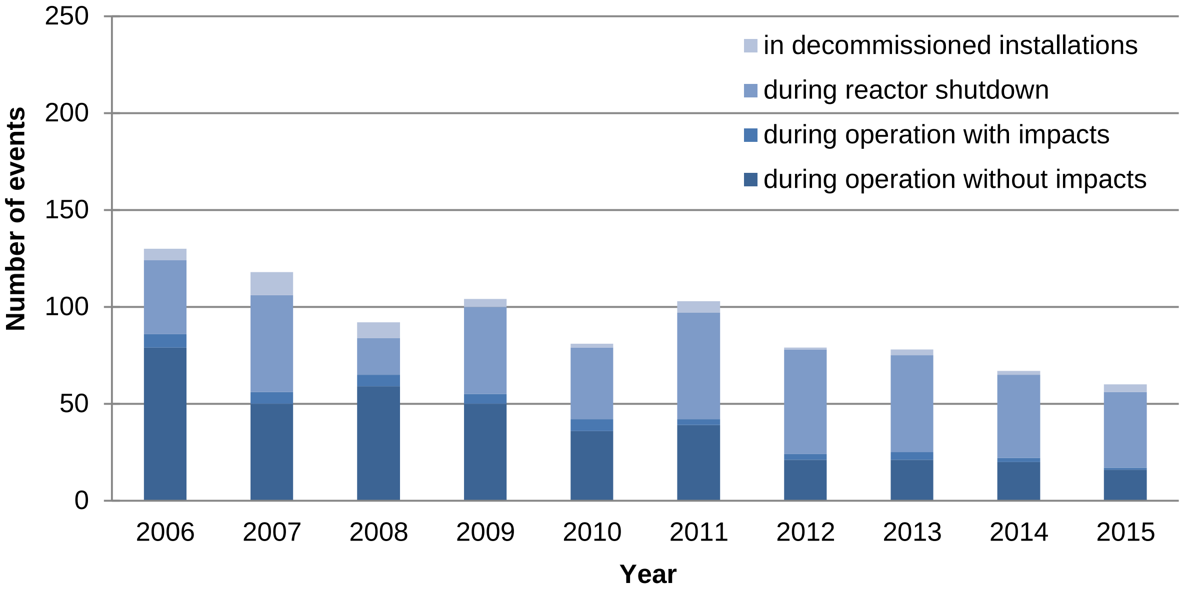

Figure 19-2 **Number of reportable events from nuclear installations for electricity generation according to mode of and impacts on operation (power operation, start-up and shutdown operation**

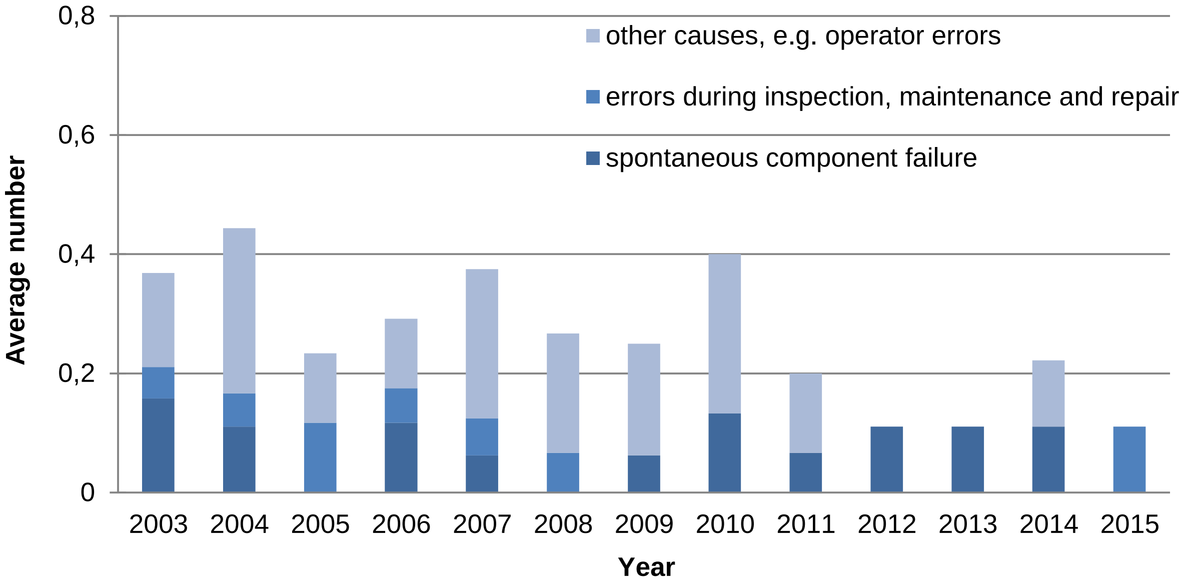

Figure 19-3 **Average number of unplanned reactor scrams per installation and year**

INES classification

Each reportable event is classified by the licence holder of a nuclear installation according to the seven levels of the International Nuclear and Radiological Event Scale (INES) of the IAEA. The INES classification of an event is included in the respective report on the event (reporting form) and is notified together with the report according to the AtSMV, which is the responsibility of the plant manager. As stipulated in the AtSMV, the nuclear safety officer has to check the report for correctness and completeness. Thus, the separation of functions reached by it also applies to the INES classification.

The INES classification is reviewed by the IAEA INES officer officially appointed by the BMUB.

Regulatory supervision

If the nuclear licensing and supervisory authority obtains information on a fact which fulfils the reporting criteria according to the AtSMV or which might fulfil the reporting criteria, the matter is reviewed and assessed at the nuclear licensing supervisory authority, usually with the participation of authorised experts according to § 20 AtG. Once all information and the evaluation of a reportable event are available, the nuclear licensing and supervisory authority defines the corrective measures required and the precautions to be taken.

19 (vii) Exchange of operating experience

The AtSMV provides the essential basis for the evaluation of operating experience. It stipulates, among others, that the nuclear safety officer shall participate in the evaluations

- of reportable events (→ Article 19 (vi)),
- of other operational occurrences in the own installation,
- of information on reportable events in other nuclear installations in terms of their significance for the own installation, and
- in the exchange of experience concerning safety-relevant operating experience with the nuclear safety officers of other nuclear installations.

Evaluation of operating experience by the licence holders

In Germany, reportable events and events below the reporting threshold of the AtSMV, e.g. failure alarms during maintenance activities, are systematically recorded and evaluated by the licence holders of nuclear installations and measures defined for correction as well as for the prevention of recurrence of similar events. This process is represented in the safety management system of the licence holder (corresponding specifications can be found in safety standard KTA 1402). If required, a so-called integrated event analysis is performed. For this purpose, the contributing factors from the areas of man-technology-organisation and their interactions are taken into account. To carry out the analysis, in 2014, the RSK has developed a guideline for the performance of integrated event analyses, which is applied by the German licence holders of nuclear installations after consultation with the VGB in 2015.

With the so-called Central Incident Reporting and Evaluation Office of VGB (VGB-ZMA), the licence holders have an own database for the exchange of generic information. The VGB-ZMA incorporates all German nuclear installations as well as the nuclear installations of the manufacturer KWU (today: AREVA GmbH) abroad. These are the nuclear installations Borssele (Netherlands), Gösgen (Switzerland), Trillo (Spain) and Angra-2 (Brazil). The reportable events are entered into this database by the individual nuclear installations in a timely manner. In addition to the reportable events, it also includes such occurrences which are below the reporting threshold, but are of interest to other nuclear installations.

Another function of the VGB-ZMA is being a connecting point to the international reporting system of WANO. In this context, WANO reports are reviewed for their safety significance with regard to German nuclear installations. A summary of selected reports is forwarded to the licence holders of the nuclear installations in German on a monthly basis and checked for applicability to their own nuclear installations.

Furthermore, there is a connection to the operating experience evaluation centre of AREVA. The manufacturer has access to selected events on the VGB-ZMA as well as to GRS information notices and reports of the International Reporting System on Operating Experiences (IRS). The applicability and relevance to German nuclear installations is checked and the results for the plant components supplied by the AREVA GmbH communicated.

The plant managers and other specialists are organised in the VGB working groups and committees and exchange more experiences at this level.

National and international evaluation of operating experience on behalf of the BMUB

The Incident Registration Centre of the BfS carries out an evaluation of the events reported from the German nuclear installations, including the classification of the events according to the AtSMV, and informs the BMUB in monthly reports. The database of the reportable events at the BfS is accessible to the nuclear licensing and supervisory authorities of the *Länder*, the BMUB and GRS. The current reportable events are discussed in the committees of the RSK on the basis of the monthly reports of the BfS.

The expert organisation GRS evaluates – partly involving other independent experts – national and international operating experience on behalf of the BMUB. The international events reported within the IRS to the IAEA and NEA are systematically reviewed for their applicability to German nuclear installations.

In case of special events in foreign nuclear installations, GRS prepares statements at short notice on behalf of BMUB. These address the safety significance and potential applicability of the event to German nuclear installations.

Should the analysis of reportable events at German and foreign nuclear installations with current or potential safety relevance show an applicability to German nuclear installations, GRS prepares information notices on behalf of the BMUB. After approval by the BMUB, these are submitted to the nuclear licensing and supervisory authorities of all *Länder* with nuclear installations, the expert organisations, the licence holders of the nuclear installations, the manufacturers and other specialised institutions.

<u>Information notices of GRS</u>

An information notice includes the following:

- description of the event,
- a root cause analysis,
- assessment of the safety significance,
- measures taken or planned by the licence holder, and
- recommendations on investigations and, where appropriate, corrective measures to be taken at other nuclear installations as an essential element of an information notice.

Each licence holder of a nuclear installation then prepares a statement for the competent nuclear licensing and supervisory authority of the *Land*. The focus of this statement is mainly on the implementation of the recommendations of the respective information notice. The plant-specific results of this information feedback are then reported to the BMUB by the respective nuclear licensing and supervisory authority of the *Land*, including information about the implementation of the recommendations made. The information feedback is evaluated by GRS and made available to all recipients of the information notice.

Moreover, GRS also performs precursor[36] analyses for reportable events in German installations and participates in international data exchange projects of the OECD/NEA.

The procedures for recording, processing, evaluation and forwarding of safety-relevant operating experience from German nuclear installations have proved themselves over the years. The process is regularly reviewed and further developed. This is to ensure that new sources of knowledge can be identified and considered in the experience feedback.

Exchange of experience

The licence holders of the nuclear installations as well as the nuclear licensing and supervisory authorities and their expert organisations have various working groups in which operational experience gained and the conclusions drawn are regularly discussed with respect to safety and the general applicability of plant-specific evaluations. Moreover, the reports of the licence holders 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 installations also being of interest for the safety of nuclear installations in other countries according to the INES and IRS manual are reported to the IAEA by GRS in coordination with the BMUB, the competent nuclear licensing and supervisory authority of the *Land* and the licence holder. Events rated INES Level 2 and above are reported to IAEA-NEWS in the short term (within 24 hours as specified). Reports with INES classification below Level 2 are forwarded if the events are of public, international interest. Since the introduction of INES, Germany has reported four events in nuclear installations classified as INES Level 2. INES Level 2 events that occur in nuclear installations abroad are immediately reported to the BMUB by GRS. The *Länder* receive information about events in foreign nuclear installations classified as INES Level 2 from the BMUB in the LAA Working Group Supervision of NPP Operation.

Regulatory supervision

The procedures of the nuclear licensing and supervisory authorities for recording, processing, evaluation and forwarding of safety-relevant operating experience from German nuclear installations have proven to be effective. However, experience also shows 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 quality of the safety assessment.

Regulatory programmes for the exchange of experience

Direct bilateral cooperation exists with neighbouring countries with nuclear installations (France, Netherlands, Switzerland, and Czech Republic). This includes an intensive exchange of operating experience (→ Article 17 (iv)). With other countries, e.g. Belgium, regulated cooperation is intended.

36 The term precursor is used for events in nuclear installations that – due to the impairment of the function of safety-relevant equipment, an operational occurrence or an accident – temporarily significantly increase the probability of damage to the reactor core. Precursor analyses calculate this probability and thus provide a measure of the safety significance of the events.

With the regulatory authorities of the contracting parties Brazil, Netherlands, Switzerland and Spain being competent for the nuclear installations of the former KWU, there is a regular exchange within the framework of the "KWU Regulators Group".

Challenge 3: Application of the new "Safety Requirements for Nuclear Power Plants"

The "Safety Requirements for Nuclear Power Plants" and their "Interpretations" have been jointly developed and adopted by the BMUB and the nuclear licensing and supervisory authorities of the *Länder* in particular to replace the "Safety Criteria for Nuclear Power Plants" in force since the 1970s. The manufacturers, licence holders of the nuclear installations and expert organisations have been consulted and involved, so that different views could largely be clarified in advance.

On the part of the nuclear licensing and supervisory authorities of the *Länder* that monitor the application and fulfilment of the "Safety Requirements for Nuclear Power Plants", no major problems in the application are known so far.

As regards the application of the "Safety Requirements for Nuclear Power Plants", the RSK prepared recommendations on behalf of the BMUB on requirements for spent fuel cooling that specify the requirements for fuel pool cooling included in the "Safety Requirements for Nuclear Power Plants". In the statement on requirements for LOCA analyses by statistical methods and the recommendation on the demonstration of residual ductility/residual strength using an ECR criterion, the RSK specifies the requirements for the safety demonstration of the "Safety Requirements for Nuclear Power Plants". When updating the national nuclear rules and regulations, it is to be examined whether and how these specifications made in the RSK statements and recommendations are taken into account.

Since their entry into force, the "Safety Requirements for Nuclear Power Plants" have been compared with the individual KTA safety standards, which is expected to be completed by 2017/2018. Since the KTA is a body in which all stakeholders are represented, including the nuclear licensing and supervisory authorities, in spring 2013, the KTA Steering Committee has asked the groups in the KTA at the request of the BMUB to point out problems but also ambiguous wordings in the application of the "Safety Requirements for Nuclear Power Plants" and their "Interpretations". A few problems described by the users led to amendments to the "Safety Requirements for Nuclear Power Plants" and their "interpretations" in 2015. Other application problems are not known so far.

19 (viii) Management of radioactive waste and spent fuel

In Germany, anyone who produces residual radioactive materials shall make provisions to ensure that they are utilised without detrimental effects or are disposed of as radioactive waste, as stipulated in § 9a para. 1 AtG. Since 1 July 2005, the shipment of spent fuel from nuclear reactors for commercial generation of electricity to facilities for reprocessing has been prohibited. The spent fuel is to be stored by the licence holders of the nuclear installations. According to the applicable legal provisions, spent fuel from nuclear reactors not used for commercial generation of electricity may be shipped to a country where research reactor fuels are supplied or manufactured. If this is not possible, this spent fuel is also to be stored.

Storage of spent fuel

Spent fuel is initially stored on site in the spent fuel pools of the nuclear installations. With the 13th AtG amendment of 2011, eight nuclear installations were shut down following the Fukushima accident in March 2011 and another in 2015. In eight of these nuclear installations, the core has already been fully unloaded and the fuel is currently in wet storage in the fuel pool. In one of the installations, the core is still in the RPV.

In the years 1998-2000, the licence holders of the nuclear installations applied for the construction of on-site storage facilities. According to § 23 AtG, the granting of the necessary storage licence falls within the competence of the BfS.

The on-site storage facilities are used for the dry storage of spent fuel in transport and storage casks. The capacity of the storage facilities is designed such to accommodate all waste produced until final cessation of power plant operation and to store it until commissioning of a disposal facility. The time of operation has been licensed for a period of 40 years, beginning with the emplacement of the first casks. Currently, 12 on-site storage facilities are operated in Germany (→ Table 19-2).

Table 19-2 On-site storage facilities for spent fuel

On-site storage facility (SZL) at the nuclear installation	Granting of 1st licence according to § 6 AtG	Capacity HM [Mg]	Storage positions for casks (occupied mid of 2016)	Start of construction	Commissioning
SZL Biblis (at KWB)	22.09.2003	1400	135 (57)	01.03.2004	18.05.2006
SZL Brokdorf (at KBR)	28.11.2003	1000	100 (29)	05.04.2004	05.03.2007
SZL Brunsbüttel (at KKB)[37]	28.11.2003	450	80 (9)	07.10.2003	05.02.2006
SZL Grafenrheinfeld (at KKG)	12.02.2003	800	88 (21)	22.09.2003	27.02.2006
SZL Grohnde (at KWG)	20.12.2002	1000	100 (27)	10.11.2003	27.04.2006
SZL Gundremmingen (at KRB)	19.12.2003	1850	192 (42)	23.08.2004	25.08.2006
SZL Isar (at KKI)	22.09.2003	1500	152 (35)	14.06.2004	12.03.2007
SZL Krümmel (at KKK)	19.12.2003	775	80 (21)	23.04.2004	14.11.2006
SZL Lingen (at KKE)	06.11.2002	1250	125 (38)	18.10.2000	10.12.2002
SZL Neckarwestheim (at GKN)	22.09.2003	1600	151 (53)	17.11.2003	06.12.2006
SZL Philippsburg (at KKP)	19.12.2003	1600	152 (40)	17.05.2004	19.03.2007
SZL Unterweser (at KKU)	22.09.2003	800	80 (27)	19.01.2004	18.06.2007
SZL Obrigheim (at KWO)	applied for in 2005	100	15	-	-

37 With the ruling of the Federal Administrative Court of 16 January 2015 to reject the complaint of the Federal Office for Radiation Protection against refusal of leave to appeal in the proceedings concerning the Brunsbüttel storage facility, the judgment of the Higher Administrative Court Schleswig by which the storage licence for the Brunsbüttel storage facility has been revoked has become final. The competent nuclear licensing and supervisory authority has issued an order pursuant to § 19 AtG according to which the storage of the nuclear fuel is tolerated until the beginning of 2018. Until then, the licensed storage is the responsibility of the operator of the storage facility.

Treatment, conditioning and disposal of radioactive waste

The licence holders draw up a waste concept for the waste produced in their nuclear installations, which is submitted to the competent nuclear licensing and supervisory authority of the *Land*. The licence holders of the nuclear installations also carry out the treatment, conditioning and disposal of radioactive waste. In these tasks, they are partly supported by specialised industrial companies.

The BfS performs an annual inventory of all spent fuel and radioactive waste as well as estimates of future quantities, including those from decommissioning. For this inventory, the volume of radioactive waste produced at the nuclear installations is also determined. Due to Council Directive 2011/70/EURATOM and the report on the national waste management programme prepared in response to it, data collection was adapted, particularly by having to specify whether the waste is intended for the Konrad repository and by introducing a new system of categories.

Minimisation of waste volumes

Pretreatment 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 disposal. All radioactive waste produced is sorted according to radioactivity and type and documented. The StrlSchV and the guideline on the control of radioactive residues and radioactive waste [3-60] specify the sorting criteria and the requirements for registration, determination of activity and documentation. Thus, the waste producers can provide information about the amount of activity and the storage place of the radioactive waste at any time.

Waste management

Germany is a contracting party to 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 relating to radioactive waste and spent fuel management, the decommissioning of nuclear facilities and the management of disused sealed sources in Germany was last given within the framework of the Fifth Review Meeting under the Joint Convention in May 2015.

Clearance

The clearance levels for radioactive materials with minor activity and the clearance procedure are specified in the StrlSchV, which defines mass-specific clearance levels for solid and liquid materials and clearance levels for

- surface contamination,
- clearance of buildings and land areas,
- clearance for disposal at landfills or in an incineration plant, and
- for metal scrap for reuse

on the basis of the 10 µSv-concept. Clearance is an official act. The necessary clearance measurements are carried out by the licence holder of a nuclear installation and are subject to the supervision by the competent regulatory authority of the *Land*, which also performs control measurements.

Regulatory supervision

The BfS performs an annual inventory of all radioactive waste produced in Germany, including the volume of radioactive waste produced at the nuclear installations. In line with the German disposal strategy, the BfS generally distinguishes between heat-generating radioactive waste and waste with negligible heat generation.

Implementation of the "Vienna Declaration on Nuclear Safety"

As described in Article 19 (iv), in German nuclear installations, provisions have been made for an emergency organisation and a crisis management team already before the nuclear accident at Fukushima. These are supported by external bodies such as the crisis management team of the manufacturer and the KHG.

In addition, HMNs have been introduced in all German nuclear installations after the Fukushima accident as part of the National Action Plan. These are plant-specific, serve to support the crisis management team and supplement the NHB. The procedures and strategies contained in these manuals comply with the international recommendations on SAMGs.

Appendix 1: Nuclear installations for electricity generation and experimental and demonstration reactors

Appendix 1-1a: Nuclear installations for electricity generation in operation

	Nuclear installations for electricity generation in operation Site	a) Licence holder b) Manufacturer c) Major shareholder	Type Gross capacity MWe	Con-struction line	a) Date of first partial licence b) First criticality
1	**Neckarwestheim 2 (GKN II)** Neckarwestheim Baden-Württemberg	a) EnBW Kernkraft (EnKK) b) KWU c) EnKK 100%	PWR 1400	4 Konvoi	a) 09.11.1982 b) 29.12.1988
2	**Philippsburg 2 (KKP 2)** Philippsburg Baden-Württemberg	a) EnBW Kernkraft (EnKK) b) KWU c) EnKK 100%	PWR 1468	3	a) 06.07.1977 b) 13.12.1984
3	**Isar 2 (KKI 2)** Essenbach Bavaria	a) E.ON Kernkraft b) KWU c) E.ON Kernkraft 75%, Stadtwerke München 25%	PWR 1485	4 Konvoi	a) 12.07.1982 b) 15.01.1988
4	**Gundremmingen B (KRB B)** Gundremmingen Bavaria	a) Kernkraftwerk Gundremmingen b) KWU c) RWE Power 75%, E.ON Kernkraft 25%	BWR 1344	72	a) 16.07.1976 b) 09.03.1984
5	**Gundremmingen C (KRB C)** Gundremmingen Bavaria	a) Kernkraftwerk Gundremmingen b) KWU c) RWE Power 75%, E.ON Kernkraft 25%	BWR 1344	72	a) 16.07.1976 b) 26.10.1984
6	**Grohnde (KWG)** Grohnde Lower Saxony	a) E.ON Kernkraft b) KWU c) E.ON Kernkraft 83.3%, Stadtwerke Bielefeld 16.7%	PWR 1430	3	a) 08.06.1976 b) 01.09.1984
7	**Emsland (KKE)** Lingen Lower Saxony	a) Kernkraftwerke Lippe-Ems b) KWU c) RWE Power 87.5%, E.ON Kernkraft 12.5%	PWR 1400	4 Konvoi	a) 04.08.1982 b) 14.04.1988
8	**Brokdorf (KBR)** Brokdorf Schleswig-Holstein	a) E.ON Kernkraft b) KWU c) E.ON Kernkraft 80%, VENE 20%	PWR 1480	3	a) 25.10.1976 b) 08.10.1986

Appendix 1-1b: Nuclear installations for electricity generation shut down due to the 13th AtG amendment

	Nuclear installations for electricity generation shut down Site	a) Licence holder b) Manufacturer c) Major shareholder	Type Gross capacity MWe	Con-struc-tion line	a) Date of first partial licence b) First criticality c) Date of shutdown
1	**Neckarwestheim 1 (GKN I)** Neckarwestheim Baden-Württemberg	a) EnBW Kernkraft (EnKK) b) KWU c) EnKK 100%	PWR 840	2	a) 24.01.1972 b) 26.05.1976 c) 06.08.2011
2	**Philippsburg 1 (KKP 1)** Philippsburg Baden-Württemberg	a) EnBW Kernkraft (EnKK) b) KWU c) EnKK 100%	BWR 926	69	a) 09.10.1970 b) 09.03.1979 c) 06.08.2011
3	**Grafenrheinfeld (KKG)** Grafenrheinfeld Bavaria	a) E.ON Kernkraft b) KWU c) E.ON Kernkraft 100%	PWR 1345	3	a) 21.06.1974 b) 09.12.1981 c) 27.06.2015
4	**Isar 1 (KKI 1)** Essenbach Bavaria	a) E.ON Kernkraft b) KWU c) E.ON Kernkraft 100%	BWR 912	69	a) 16.05.1972 b) 20.11.1977 c) 06.08.2011
5	**Biblis A (KWB A)** Biblis Hesse	a) RWE Power b) KWU c) RWE Power 100%	PWR 1225	2	a) 31.07.1970 b) 16.07.1974 c) 06.08.2011
6	**Biblis B (KWB B)** Biblis Hesse	a) RWE Power b) KWU c) RWE Power 100%	PWR 1300	2	a) 06.04.1972 b) 25.03.1976 c) 06.08.2011
7	**Unterweser (KKU)** Esenshamm Lower Saxony	a) E.ON Kernkraft b) KWU c) E.ON Kernkraft 100%	PWR 1410	2	a) 28.06.1972 b) 16.09.1978 c) 06.08.2011
8	**Brunsbüttel (KKB)** Brunsbüttel Schleswig-Holstein	a) Kernkraftwerk Brunsbüttel b) AEG/KWU c) VENE 66.7%, E.ON Kernkraft 33.3%	BWR 806	69	a) 02.04.1970 b) 23.06.1976 c) 06.08.2011
9	**Krümmel (KKK)** Krümmel Schleswig-Holstein	a) Kernkraftwerk Krümmel b) KWU c) VENE 50%, E.ON Kernkraft 50%	BWR 1402	69	a) 18.12.1973 b) 14.09.1983 c) 06.08.2011

Appendix 1-2: Nuclear installations for electricity generation and experimental and demonstration reactors under decommissioning

Nuclear installations for electricity generation under decommissioning Site		**a) Last licence holder** **b) Manufacturer** **c) Licence holder decommissioning**	**Type Gross capacity MWe**	**a) First criticality** **b) Shutdown** **c) First decommissioning licence**
1	**Kompakte natriumgekühlte Reaktoranlage (KNK II)** Karlsruhe Baden-Württemberg	a) Kernkraftwerk Betriebsgesellschaft mbH b) Interatom c) Wiederaufarbeitungsanlage Karlsruhe Rückbau- und Entsorgungs-GmbH	SNR 21	a) 10.10.1977 b) 23.08.1991 c) 26.08.1993
2	**Mehrzweckforschungsreaktor (MZFR)** Eggenstein-Leopoldshafen Baden-Württemberg	a) Kernkraftwerk Betriebsgesellschaft mbH b) Siemens/KWU c) Wiederaufarbeitungsanlage Karlsruhe Rückbau- und Entsorgungs-GmbH	Pressurised heavy water reactor 57	a) 29.09.1965 b) 03.05.1984 c) 17.11.1987
3	**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 c) 28.08.2008
4	**Gundremmingen A (KRB A)** Gundremmingen Bavaria	a) Kernkraftwerk RWE-Bayernwerk b) AEG/General Electric c) Kernkraftwerk Gundremmingen	BWR 250	a) 14.08.1966 b) 13.01.1977 c) 26.05.1983
5	**Rheinsberg (KKR)** Rheinsberg Brandenburg	a) Energiewerke Nord b) VEB Kernkraftwerksbau Berlin c) Energiewerke Nord	PWR (WWER) 70	a) 11.03.1966 b) 01.06.1990 c) 28.04.1995
6	**Greifswald 1 (KGR 1)** Lubmin Mecklenburg-West Pomerania	a) Energiewerke Nord b) VEB Kombinat Kraftwerksanlagenbau c) Energiewerke Nord	PWR (WWER) 440	a) 03.12.1973 b) 18.12.1990 c) 30.06.1995
7	**Greifswald 2 (KGR 2)** Lubmin Mecklenburg-West Pomerania	a) Energiewerke Nord b) VEB Kombinat Kraftwerksanlagenbau c) Energiewerke Nord	PWR (WWER) 440	a) 03.12.1974 b) 14.02.1990 c) 30.06.1995
8	**Greifswald 3 (KGR 3)** Lubmin Mecklenburg-West Pomerania	a) Energiewerke Nord b) VEB Kombinat Kraftwerksanlagenbau c) Energiewerke Nord	PWR (WWER) 440	a) 06.10.1977 b) 28.02.1990 c) 30.06.1995
9	**Greifswald 4 (KGR 4)** Lubmin Mecklenburg-West Pomerania	a) Energiewerke Nord b) VEB Kombinat Kraftwerksanlagenbau c) Energiewerke Nord	PWR (WWER) 440	a) 22.07.1979 b) 02.06.1990 c) 30.06.1995
10	**Greifswald 5 (KGR 5)** Lubmin Mecklenburg-West Pomerania	a) Energiewerke Nord b) VEB Kombinat Kraftwerksanlagenbau c) Energiewerke Nord	PWR (WWER) 440	a) 26.03.1989 b) 30.11.1989 c) 30.06.1995

Nuclear installations for electricity generation under decommissioning Site		a) Last licence holder b) Manufacturer c) Licence holder decommissioning	Type Gross capacity MWe	a) First criticality b) Shutdown c) First decommissioning licence
11	**Lingen (KWL)** Lingen Lower Saxony	a) Kernkraftwerk Lingen b) AEG/KWU c) Kernkraftwerk Lingen	BWR 252	a) 31.01.1968 b) 05.01.1977 c) 21.11.1985 (safe enclosure (SE)) 21.12.2015 (dismantling)
12	**Stade (KKS)** Stade Lower Saxony	a) E.ON Kernkraft b) KWU c) E.ON Kernkraft	PWR 672	a) 08.01.1972 b) 14.11.2003 c) 07.09.2005
13	**Atomversuchskraftwerk (AVR)** Jülich North Rhine-Westphalia	a) Arbeitsgemeinschaft Versuchsreaktor b) BBC/Krupp Reaktorbau (BBK) c) Jülicher Entsorgungsgesellschaft für Nuklearanlagen mbH (JEN)	HTR 15	a) 26.08.1966 b) 31.12.1988 c) 09.03.1994 SE
14	**Thorium-Hochtemperaturreaktor (THTR 300)** Hamm-Uentrop North Rhine-Westphalia	a) Hochtemperatur Kernkraftwerk b) BBC/HRB/NUKEM c) Hochtemperatur Kernkraft GmbH (HKG)	HTR 308	a) 13.09.1983 b) 29.09.1988 c) 22.10.1993
15	**Würgassen (KWW)** Würgassen North Rhine-Westphalia	a) E.ON Kernkraft b) AEG/KWU c) E.ON Kernkraft	BWR 670	a) 22.10.1971 b) 26.08.1994 c) 14.04.1997
16	**Mülheim-Kärlich (KMK)** Mülheim-Kärlich Rhineland-Palatinate	a) RWE Power b) BBR c) RWE Power	PWR 1302	a) 01.03.1986 b) 09.09.1988 c) 16.07.2004

Appendix 1-3: Nuclear installations for electricity generation completely dismantled and released from the scope of the AtG

	Nuclear installations for electricity generation, completely dismantled and released from the scope of the AtG Site	a) Last licence holder b) Manufacturer	Type Gross capacity MWe	a) First criticality b) Shutdown c) Release from AtG
1	**Heißdampfreaktor Großwelzheim (HDR)** Karlstein Bavaria	a) Forschungszentrum Karlsruhe b) AEG	Superheated steam cooled reactor 25	a) 14.10.1969 b) 20.04.1971 c) 14.05.1998
2	**Niederaichbach (KKN)** Niederaichbach Bavaria	a) Forschungszentrum Karlsruhe b) Siemens	Pressure tube reactor 106	a) 17.12.1972 b) 31.07.1974 c) 17.08.1994
3	**Versuchsatomkraft-werk Kahl (VAK)** Karlstein Bavaria	a) Versuchsatomkraftwerk Kahl b) AEG/General Electric	BWR 16	a) 13.11.1960 b) 25.11.1985 c) 17.05.2010

Appendix 1-4: Abandoned projects

	Abandoned projects Site	a) Last licence holder b) Manufacturer	Type Gross capacity MWe	Status
1	**Greifswald 6 (KGR 6)** Lubmin Mecklenburg-West Pomerania	a) Energiewerke Nord b) VEB Kombinat Kraftwerksan-lagenbau	PWR (WWER) 440	Project abandoned
2	**Greifswald 7 (KGR 7)** Lubmin Mecklenburg-West Pomerania	a) Energiewerke Nord b) VEB Kombinat Kraftwerksan-lagenbau	PWR (WWER) 440	Project abandoned
3	**Greifswald 8 (KGR 8)** Lubmin Mecklenburg-West Pomerania	a) Energiewerke Nord b) VEB Kombinat Kraftwerksan-lagenbau	PWR (WWER) 440	Project abandoned
4	**SNR 300** Kalkar North Rhine-Westphalia	a) Schnell-Brüter Kernkraft-werksgesellschaft b) INTERATOM/ BELGONUCLEAIRE/ NERATOOM	SNR 327	Project abandoned 20.03.1991
5	**Stendal A** Stendal Saxony-Anhalt	a) Altmark Industrie b) VEB Kombinat Kraftwerksan-lagenbau	PWR (WWER) 1000	Project abandoned
6	**Stendal B** Stendal Saxony-Anhalt	a) Altmark Industrie b) VEB Kombinat Kraftwerksan-lagenbau	PWR (WWER) 1000	Project abandoned

Appendix 2: Research reactors

Appendix 2-1a: Research reactors in operation

	Research reactor Site	**Licence holder**	**Reactor type** **Thermal output [MWth]** **th. n-flux [cm^{-2}s^{-1}]**	**First criticality**
1	**SUR-FW** Furtwangen Baden-Württemberg	Hochschule Furtwangen	SUR-100 $1{\cdot}10^{-7}$ $6{\cdot}10^{6}$	28.06.1973
2	**SUR-S** Stuttgart Baden-Württemberg	Universität Stuttgart Institut für Kernenergetik und Energiesysteme	SUR-100 $1{\cdot}10^{-7}$ $6{\cdot}10^{6}$	24.08.1964
3	**SUR-U** Ulm Baden-Württemberg	Fachhochschule Ulm Labor für Strahlenmesstechnik und Reaktortechnik	SUR-100 $1{\cdot}10^{-7}$ $5{\cdot}10^{6}$	01.12.1965
4	**FRM-II** Garching Bavaria	Technische Universität München	Swimming pool/ compact core 20 $8{\cdot}10^{14}$	02.03.2004
5	**BER II** Berlin	Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (HZB)	Swimming pool/MTR 10 $1{\cdot}10^{14}$	09.12.1973
6	**FRMZ** Mainz Rhineland-Palatinate	Universität Mainz Institut für Kernchemie	Swimming pool / TRIGA Mark II 0.1 $4{\cdot}10^{12}$	03.08.1965
7	**AKR-2** Dresden Saxony	Technische Universität Dresden Institut für Energietechnik	SUR-type $2{\cdot}10^{-6}$ $3{\cdot}10^{7}$	22.03.2005 (AKR-1: 28.07.1978)

Appendix 2-1b: Research reactors permanently shut down

Research reactors permanently shut down, no decommissioning licence granted yet Site		**Licence holder**	**Reactor type** **Thermal output [MWth]** **th. n-flux [$cm^{-2}s^{-1}$]**	**a) First criticality** **b) Date of shutdown** **c) Application for decommissioning**
1	**SUR-H** Hannover Lower Saxony	Leibniz Universität Hannover Institut für Kerntechnik und zerstörungsfreie Prüfverfahren	SUR-100 $1 \cdot 10^{-7}$ $6 \cdot 10^{6}$	a) 09.12.1971 b) since 2008 out of operation and free of nuclear fuel c) 22.10.2013
2	**SUR-AA** Aachen North Rhine-Westphalia	RWTH Aachen Institut für elektrische Anlagen und Energiewirtschaft	SUR-100 $1 \cdot 10^{-7}$ $6 \cdot 10^{6}$	a) 22.09.1965 b) since 2002 out of operation and since 2008 free of nuclear fuel c) 2010
3	**FRG-1** Geesthacht Schleswig-Holstein	Helmholtz-Zentrum Geesthacht Zentrum für Material- und Küstenforschung GmbH	Swimming pool/MTR 5 $1 \cdot 10^{14}$	a) 23.10.1958 b) 28.06.2010 c) 21.03.2013[2]
4	**FRG-2** Geesthacht Schleswig-Holstein	Helmholtz-Zentrum Geesthacht Zentrum für Material- und Küstenforschung GmbH	Swimming pool/MTR 15 $2 \cdot 10^{14}$	a) 16.03.1963 b) 28.01.1993[38] c) 21.03.2013[39]

38 Application for decommissioning and partial dismantling

39 Application for dismantling of the research reactor facility (consisting of the FRG-1 and parts of the FRG-2 still existing)

Appendix 2-2: Research reactors under decommissioning

Research reactors under decommissioning Site		Licence holder	Reactor type Thermal output [MWth] th. n-flux [cm-2s-1]	a) First criticality b) Shutdown c) Status
1	**FR-2** Eggenstein-Leopoldshafen Baden-Württemberg	Wiederaufarbeitungsanlage Karlsruhe Rückbau- und Entsorgungs-GmbH	Tank-type/D_2O reactor 44 $1{\cdot}10^{14}$	a) 07.03.1961 b) 21.12.1981 c) 20.11.1996 SE
2	**FRM** Garching Bavaria	Technische Universität München	Swimming pool/MTR 4 $7{\cdot}10^{13}$	a) 31.10.1957 b) 28.07.2000 c) 03.04.2014 (decommissioning licence (DL))
3	**FRN** Oberschleißheim Bavaria	Helmholtz Zentrum München – Deutsches Forschungszentrum für Gesundheit und Umwelt GmbH	Swimming pool/ TRIGA Mark III 1 $3{\cdot}10^{13}$	a) 23.08.1972 b) 16.12.1982 c) 24.05.1984 SE
4	**FMRB** Braunschweig Lower Saxony	Physikalisch Technische Bundesanstalt Braunschweig	Swimming pool/MTR 1 $6{\cdot}10^{12}$	a) 03.10.1967 b) 19.12.1995 c) 28.07.2005 facility released from AtG except for storage facility
5	**FRJ-2 (DIDO)** Jülich North Rhine-Westphalia	Jülicher Entsorgungsgesellschaft für Nuklearanlagen mbH (JEN)	Tank-type/D_2O reactor 23 $2{\cdot}10^{14}$	a) 14.11.1962 b) 02.05.2006 c) 20.09.2012 DL
6	**RFR** Rossendorf Saxony	VKTA – Strahlenschutz, Analytik und Entsorgung Rossendorf e.V.	Tank-type/WWR-S(M) 10 $1{\cdot}10^{14}$	a) 16.12.1957 b) 27.06.1991 c) 30.01.1998 DL

Appendix 2-3: Research reactors, decommissioning completed or released from the scope of the AtG

Decommissioning completed or released from the scope of the AtG Site		Licence holder	Reactor type Thermal output [MWth] th. n-flux [$cm^{-2}s^{-1}$]	a) First criticality b) Shutdown
1	**SNEAK** Eggenstein-Leopoldshafen Baden-Württemberg	Karlsruher Institut für Technologie	Homogeneous reactor $1\cdot10^{-3}$ $7\cdot10^{6}$	a) 15.12.1966 b) 11/1985
2	**SUAK** Eggenstein-Leopoldshafen Baden-Württemberg	Karlsruher Institut für Technologie	Subcritical assembly	a) 20.11.1964 b) 07.12.1978
3	**STARK** Eggenstein-Leopoldshafen Baden-Württemberg	Karlsruher Institut für Technologie	Argonaut $1\cdot10^{-5}$ $1\cdot10^{8}$	a) 11.01.1963 b) 03/1976
4	**SUR-KA** Eggenstein-Leopoldshafen Baden-Württemberg	Karlsruher Institut für Technologie	SUR-100 $1\cdot10^{-7}$ $6\cdot10^{6}$	a) 07.03.1966 b) 09/1996
5	**TRIGA HD I** Heidelberg Baden-Württemberg	Deutsches Krebs-forschungszentrum	Swimming pool/ TRIGA Mark I 0.25 $1\cdot10^{13}$	a) 26.08.1966 b) 31.03.1977
6	**TRIGA HD II** Heidelberg Baden-Württemberg	Deutsches Krebsforschungszentrum	Swimming pool/ TRIGA Mark I 0.25 $1\cdot10^{13}$	a) 28.02.1978 b) 30.11.1999
7	**AEG Nullenergie Reaktor (TKA)** Karlstein Bavaria	Kraftwerk Union	Tank-type/critical assem-bly $1\cdot10^{-4}$ $1\cdot10^{8}$	a) 23.06.1967 b) 1973
8	**AEG Prüfreaktor PR-10** Karlstein Bavaria	Kraftwerk Union	Argonaut $1.8\cdot10^{-4}$ $3\cdot10^{10}$	a) 27.01.1961 b) 1976
9	**SAR** Garching Bavaria	Technische Universität München	Argonaut $1\cdot10^{-3}$ $2\cdot10^{11}$	a) 23.06.1959 b) 31.10.1968
10	**SUA** Garching Bavaria	Technische Universität München	Subcritical assembly	a) 06/1959 b) 1968
11	**SUR-M** Garching Bavaria	Technische Universität München	SUR-100 $1\cdot10^{-7}$ $6\cdot10^{6}$	a) 28.02.1962 b) 10.08.1981

Decommissioning completed or released from the scope of the AtG Site		Licence holder	Reactor type Thermal output [MWth] th. n-flux [$cm^{-2}s^{-1}$]	a) First criticality b) Shutdown
12	**BER I** Berlin	Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (HZB)	Homogeneous reactor 0.05 $2 \cdot 10^{12}$	a) 24.07.1958 b) 1972
13	**SUR-B** Berlin	Technische Universität Berlin, Institut für Energietechnik	SUR-100 $1 \cdot 10^{-7}$ $5 \cdot 10^{6}$	a) 26.07.1963 b) 15.10.2007
14	**SUR-HB** Bremen	Hochschule Bremen	SUR-100 $1 \cdot 10^{-7}$ $6 \cdot 10^{6}$	a) 10.10.1967 b) 17.06.1993
15	**SUR-HH** Hamburg	Fachhochschule Hamburg	SUR-100 $1 \cdot 10^{-7}$ $6 \cdot 10^{6}$	a) 15.01.1965 b) 8/1992
16	**FRF 1** Frankfurt Hesse	Johann Wolfgang Goethe Universität Frankfurt	Homogeneous reactor 0.05 $1 \cdot 10^{12}$	a) 10.01.1958 b) 19.03.1968
17	**FRF 2** Frankfurt Hesse	Johann Wolfgang Goethe Universität Frankfurt	Modified TRIGA 1 $3 \cdot 10^{13}$	a) no criticality b) project abandoned, no operation
18	**SUR-DA** Darmstadt Hesse	Technische Hochschule Darmstadt	SUR-100 $1 \cdot 10^{-7}$ $6 \cdot 10^{6}$	a) 23.09.1963 b) 22.02.1985
19	**FRH** Hannover Lower Saxony	Medizinische Hochschule Hannover	Swimming pool/ TRIGA Mark I 0.25 $9 \cdot 10^{12}$	a) 31.01.1973 b) 18.12.1996
20	**ADIBKA (L77A)** Jülich North Rhine-Westphalia	Forschungszentrum Jülich	Homogeneous reactor $1 \cdot 10^{-4}$ $3 \cdot 10^{8}$	a) 18.03.1967 b) 30.10.1972
21	**FRJ-1 (MERLIN)** Jülich North Rhine-Westphalia	Forschungszentrum Jülich	Swimming pool/MTR 10 $1 \cdot 10^{14}$	a) 24.02.1962 b) 22.03.1985
22	**KAHTER** Jülich North Rhine-Westphalia	Forschungszentrum Jülich	Critical assembly $1 \cdot 10^{-4}$ $2 \cdot 10^{8}$	a) 02.07.1973 b) 03.02.1984
23	**KEITER** Jülich North Rhine-Westphalia	Forschungszentrum Jülich	Critical assembly $1 \cdot 10^{-6}$ $2 \cdot 10^{7}$	a) 15.06.1971 b) 1982
24	**RAKE** Rossendorf Saxony	VKTA – Strahlenschutz, Analytik und Entsorgung Rossendorf e.V.	Tank-type/ Critical assembly $1 \cdot 10^{-5}$ $1 \cdot 10^{8}$	a) 03.10.1969 b) 26.11.1991

Decommissioning completed or released from the scope of the AtG Site		Licence holder	Reactor type Thermal output [MWth] th. n-flux [$cm^{-2}s^{-1}$]	a) First criticality b) Shutdown
25	**RRR** Rossendorf Saxony	VKTA – Strahlenschutz, Analytik und Entsorgung Rossendorf e.V.	Argonaut $1{\cdot}10^{-3}$ $2{\cdot}10^{11}$	a) 16.12.1962 b) 25.09.1991
26	**ZLFR** Zittau Saxony	Hochschule Zittau/Görlitz, Fachbereich Maschinen-wesen	Tank-type/WWR-M $1{\cdot}10^{-5}$ $2{\cdot}10^{8}$	a) 25.05.1979 b) 24.03.2005
27	**ANEX** Geesthacht Schleswig-Holstein	Helmholtz-Zentrum Geesthacht Zentrum für Material- und Küstenfor-schung GmbH	Critical assembly $1{\cdot}10^{-7}$ $2{\cdot}10^{8}$	a) 05/1964 b) 05.02.1975
28	**NS OTTO HAHN** Geesthacht Schleswig-Holstein	Helmholtz-Zentrum Geesthacht Zentrum für Material- und Küstenfor-schung GmbH	PWR ship reactor 38 $3{\cdot}10^{13}$	a) 26.08.1968 b) 22.03.1979
29	**SUR-KI** Kiel Schleswig-Holstein	Fachhochschule Kiel	SUR-100 $1{\cdot}10^{-7}$ $6{\cdot}10^{6}$	a) 29.03.1966 b) 11.12.1997

Appendix 3: Design basis accidents and beyond-design-basis event sequences (for PWRs and BWRs) considered in the safety reviews (→ Table 14-1) carried out during the reporting period in accordance with the PSR guideline [3-74.1]

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 events • 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 hazards • 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 hazards • Site-specific, natural external hazards (due to earthquake and weather condition such as lightning, flooding, wind, ice and snow)	

Level 4, beyond-design-basis accidents **PWR**

4-1 Special, 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 two 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 accident 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 hazards
- 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 hazards
- Site-specific, natural external hazards (due to earthquake and weather condition such as lightning, flooding, wind, ice and snow)

Level 4, beyond-design-basis accidents	BWR
4-1 Special, 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 two 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: Safety-related design characteristics, 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 generator, 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 above 400 mm			Like construction lines 1-3, but with optimised qualities
– Ageing-resistant stabilised austenitic steels	All pipes with nominal diameter below 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
Recirculation 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	
– Application of the break preclusion concept	Pipes[40], partly refitted 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[41]
Reduction of embrittlement from neutron radiation exposure	Special fuel element management (low leakage loading)	

40 for KRB II: Only stabilised austenitic pipes are used.

41 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 at least 50% each			
Pump head of high-pressure pumps	Approx. 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	Approx. 10 bar		
Accumulators (injection pressure)	1 per loop (26 bar); 1 plant without accumulators	1 or 2 pro Loop (25 bar)	2 pro 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)	2 in total, 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 evacua-tion	Double seals with evacuation		
– Personnel airlock	Single or double seals without evacua-tion	Double seals with evacuation		
– Emergency airlock	One with single seal	One with double seals and evacuation	One with single seal	
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			With a few ex-ceptions, one isolation valve each inside and outside of con-tainment
– 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	Approx. 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 active pipes in the pressure suppression pool	Depending on the plant: 58, 62 or 72	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 the upper containment region	One, from the upper containment region
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 I&C, including reactor protection system

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 shutdown reactivity)			
Limitations of coolant pressure, coolant mass and temperature gradient	Coolant pressure	Partially	Yes	

4.2 Safety I&C, including reactor protection system

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 I&C, including reactor protection system

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

4.2 Safety I&C, including reactor protection system

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.	

5.1 Electrical 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 alto-gether, or 4 trains with 1 diesel each	4 trains with 1 diesel each		
Additional emergency power supply for the control of exter-nal impacts	2 trains	1-2 trains, unit support system at one double-unit plant	2 trains	
Uninterruptible DC power sup-ply	2 x 2 trains	4 trains (except for 1 plant with 2 x 4 trains)	3 x 4 trains	
Protected DC power supply	At least 2 h			
Separation of trains	Intermeshed emergency pow-er supply, physical separa-tion of the emer-gency power supply grids	Separation of trains	Intermeshed emergency power sup-ply, physical separation of the emergency power supply grids	

5.2 Electrical 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 h	
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 hazards 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 hazards 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 rules and regulations

Selection of rules and regulations concerning nuclear installations; 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/gesetze-regelungen/rsh/rsh_node.html)

Note: Titles in 1 to 4 are given in the original language German without translation

Contents

1 Legislation

1A National legislation on nuclear safety and radiation protection

1A-1 **Grundgesetz** für die Bundesrepublik Deutschland in der im Bundesgesetzblatt Teil III, Gliederungsnummer 100-1 veröffentlichten bereinigten Fassung, das zuletzt durch Artikel 1 des Gesetzes vom 23. Dezember 2014 (BGBl.I 2014, Nr. 64, S. 2438) geändert worden ist.
Hinweis: *geändert bezüglich 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), das zuletzt durch Artikel 92 der Verordnung vom 31. August 2015 (BGBl.I 2015, Nr. 35, S. 1474) geändert worden ist

1A-2.4 Gesetz über die **Errichtung eines Bundesamtes für kerntechnische Entsorgung** - BfkEG - vom 23. Juli 2013 (BGBl.I 2013, Nr. 41, S. 2553), das durch Artikel 310 der Verordnung vom 31. August 2015 (BGBl.I 2015, Nr. 35, S. 1474) geändert worden ist

1A-2.5 **Organisationserlass** der Bundeskanzlerin vom 17. Dezember 2013 (BGBl.I 2013, Nr. 75, S. 4310)
Hinweis: *Umbenennung des BMU in Bundesministerium für Umweltschutz, Naturschutz, Bau und Reaktorsicherheit (BMUB) und Übertragung weiterer Zuständigkeiten*

1A-2.6 Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit - Bekanntmachung **Organisationserlass zur Errichtung des Bundesamtes für kerntechnische Entsorgung** vom 5. August 2014 (BAnz AT 27.08.2014 B4)

1A-3 Gesetz über die friedliche Verwendung der Kernenergie und den Schutz gegen ihre Gefahren (**Atomgesetz** - AtG) in der Fassung der Bekanntmachung vom 15. Juli 1985 (BGBl.I 1985, Nr. 41, S. 1565), das zuletzt durch Artikel 1 des Gesetzes vom 20. November 2015 (BGBl.I 2015, Nr. 46, S. 2053) geändert worden ist
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), das zuletzt durch Artikel 91 der Verordnung vom 31. August 2015 (BGBl.I 2015, Nr. 35, S. 1474) geändert worden ist

1A-8 Verordnung über den Schutz vor Schäden durch ionisierende Strahlen (**Strahlenschutzverordnung** - StrlSchV) vom 20. Juli 2001 (BGBl.I 2001, Nr. 38, S. 1714), die zuletzt durch Artikel 5 der Verordnung vom 27. April 2016 (BGBl.I 2016, Nr. 20, S. 980) geändert worden ist
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-9 **Dosiskoeffizienten** zur Berechnung der Strahlenexposition in BAnz 2001, Nr. 160a und 160b

1A-10 Verordnung über das Verfahren bei der Genehmigung von Anlagen nach § 7 des Atomgesetzes (**Atomrechtliche Verfahrensverordnung** - AtVfV) in der Fassung der Bekanntmachung vom 3. Februar 1995 (BGBl.I 1995, Nr. 8, S. 180), die zuletzt durch Artikel 4 des Gesetzes vom 9. Dezember 2006 (BGBl.I 2006, Nr. 58, S. 2819) geändert worden ist

1A-11 Verordnung über die Deckungsvorsorge nach dem Atomgesetz (**Atomrechtliche Deckungsvorsorge-Verordnung** - AtDeckV) vom 25. Januar 1977 (BGBl.I 1977, Nr. 8, S. 220), die zuletzt durch Artikel 2 Absatz 15 des Gesetzes vom 1. April 2015 (BGBl.I 2015, Nr. 14. S. 434 geändert worden ist

1A-12 **Kernbrennstoffsteuergesetz** - KernbrStG - vom 8. Dezember 2010 (BGBl.I 2010, Nr. 62, S. 1804), das durch Artikel 240 der Verordnung vom 31. August 2015 (BGBl.I 2015, Nr. 35, S. 1474) geändert worden ist

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), die zuletzt durch Artikel 1 der Verordnung vom 6. Juli 2004 (BGBl.I 2004, Nr. 33, S. 1476) geändert worden ist

1A-17 Verordnung über den kerntechnischen Sicherheitsbeauftragten und über die Meldung von Störfällen und sonstigen Ereignissen (**Atomrechtliche Sicherheitsbeauftragten- und Meldeverordnung** - AtSMV) vom 14. Oktober 1992 (BGBl.I 1992, Nr. 48, S. 1766), die zuletzt durch Artikel 1 der Verordnung vom 8. Juni 2010 (BGBl.I 2010, Nr. 31, S. 755) geändert worden ist

1A-18 Verordnung über die Verbringung radioaktiver Abfälle oder abgebrannter Brennelemente (**Atomrechtliche Abfallverbringungsverordnung** - AtAV) vom 30. April 2009 (BGBl.I 2009, Nr. 24, S. 1000), die durch Artikel 308 der Verordnung vom 31. August 2015 (BGBl.I 2015, Nr. 35, S. 1474) geändert worden ist

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), die zuletzt durch Artikel 1 der Verordnung vom 22. Juni 2010 (BGBl.I 2010, Nr. 34, S. 825) geändert worden ist

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), die durch Artikel 70 des Gesetzes vom 21. Juni 2005 (BGBl.I 2005, Nr. 39, S. 1818) geändert worden ist

1A-21 **Kostenverordnung zum Atomgesetz** - AtKostV - vom 17. Dezember 1981 (BGBl.I 1981, Nr. 56, S. 1457), die zuletzt durch Artikel 2 Absatz 96 des Gesetzes vom 7. August 2013 (BGBl.I 2013, Nr. 48, S. 3154) geändert worden ist

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), die durch Artikel 1 der Verordnung vom 7. Juli 2015 (BAnz AT 21.07.2015 V1) geändert worden ist

1A-25 Gesetz zur Suche und Auswahl eines Standortes für ein Endlager für Wärme entwickelnde radioaktive Abfälle (**Standortauswahlgesetz** - StandAG) vom 23. Juli 2013 (BGBl.I 2013, Nr. 41, S. 2553), das durch Artikel 309 der Verordnung vom 31. August 2015 (BGBl.I 2015, Nr. 35, S. 1474) geändert worden ist

1B Other national legal provisions also to be applied in nuclear safety and radiation protection

1B-1 **Verwaltungsverfahrensgesetz** - VwVfG - in der Fassung der Bekanntmachung vom 23. Januar 2003 (BGBl.I 2003, Nr. 4, S. 102), das zuletzt durch Artikel 1 des Gesetzes vom 20. November 2015 (BGBl.I 2015, Nr. 46, S. 2010) geändert worden ist

1B-2.1 **Umweltinformationsgesetz** - UIG - in der Fassung der Bekanntmachung vom 27. Oktober 2014 (BGBl. I 2014, Nr. 49, S. 1643)

1B-2.2 **Umweltinformationsgebührenverordnung** - UIGgebV - in der Fassung der Bekanntmachung vom 23. August 2001 (BGBl.I 2001, Nr. 45, S. 2247), die zuletzt durch Artikel 2 Absatz 40 des Gesetzes vom 7. August 2013 (BGBl.I 2013, Nr. 48, S. 3154) geändert worden ist

1B-3 **Umweltverträglichkeitsprüfungsgesetz** - UVPG - in der Fassung der Bekanntmachung vom 24. Februar 2010 (BGBl.I 2010, Nr. 7, S. 94), das zuletzt durch Artikel 2 des Gesetzes vom 21. Dezember 2015 (BGBl.I 2015, Nr. 55, S. 2490) geändert worden ist

1B-4 **Umweltauditgesetz** - UAG - in der Fassung der Bekanntmachung vom 4. September 2002 (BGBl.I 2002, Nr. 64, S. 3490), das zuletzt durch Artikel 3 des Gesetzes vom 25. November 2015 (BGBl.I 2015, Nr. 47, S. 2092) geändert worden ist

1B-10 **Umwelthaftungsgesetz** - UmweltHG - vom 10. Dezember 1990 (BGBl.I 1990, Nr. 67, S. 2634), das zuletzt durch Artikel 9 Absatz 5 des Gesetzes vom 23. November 2007 (BGBl.I 2007, Nr. 59, S. 2631) geändert worden ist

1B-11 **Strafgesetzbuch** - StGB - in der Fassung der Bekanntmachung vom 13. November 1998 (BGBl.I 1998, Nr. 75, S. 3322), das zuletzt durch Artikel 5 des Gesetzes vom 10. Dezember 2015 (BGBl.I 2015, Nr. 51, S. 2218) geändert worden ist

1B-14 **Raumordnungsgesetz** - ROG - vom 22. Dezember 2008 (BGBl.I 2008, Nr. 65, S. 2986), das zuletzt durch Artikel 124 der Verordnung vom 31. August 2015 (BGBl.I 2015, Nr. 35, S. 1474) geändert worden ist

1B-16 Gesetz zum Schutz vor schädlichen Umwelteinwirkungen durch Luftverunreinigungen, Geräusche, Erschütterungen und ähnliche Vorgänge (**Bundes-Immissionsschutzgesetz** - BImSchG) in der Fassung der Bekanntmachung vom 17. Mai 2013 (BGBl.I 2013, Nr. 25, S. 1274), das zuletzt durch Artikel 76 der Verordnung vom 31. August 2015 (BGBl.I 2015, Nr. 35, S. 1474) geändert worden ist

1B-24 Gesetz zur Förderung der Kreislaufwirtschaft und Sicherung der umweltverträglichen Bewirtschaftung von Abfällen (**Kreislaufwirtschaftsgesetz**- KrWG) vom 24. Februar 2012 (BGBl.I 2012, Nr. 10, S. 212), das zuletzt durch Artikel 4 des Gesetzes vom 4. April 2016 (BGBl.I 2016, Nr. 15, S. 569) geändert worden ist

1B-27 **Wasserhaushaltsgesetz** - WHG - vom 31. Juli 2009 (BGBl.I 2009, Nr. 51, S. 2585), das zuletzt durch Artikel 320 der Verordnung vom 31. August 2015 (BGBl.I 2015, Nr. 35, S. 1474) geändert worden ist, die Änderung durch Artikel 1 des Gesetzes vom 11. April 2016 (BGBl.I 2016, Nr. 17, S. 745) tritt am 18. Oktober 2016 in Kraft

1B-29 Gesetz über Naturschutz und Landschaftspflege (**Bundesnaturschutzgesetz** - BNatSchG) vom 29. Juli 2009 (BGBl.I 2009, Nr. 51, S. 2542), das zuletzt durch Artikel 421 der Verordnung vom 31. August 2015 (BGBl.I 2015, Nr. 35, S. 1474) geändert worden ist

1B-31 Verordnung zum Schutz vor Gefahrstoffen (**Gefahrstoffverordnung** - GefStoffV) vom 26. November 2010 (BGBl.I 2010, Nr. 59, S. 1643), die zuletzt durch Artikel 2 der Verordnung vom 3. Februar 2015 (BGBl.I 2015, Nr. 4, S. 49) geändert worden ist

1B-32 Verordnung über die Qualität von Wasser für den menschlichen Gebrauch (**Trinkwasserverordnung** - TrinkwV 2001) in der Fassung der Bekanntmachung vom 10. März 2016 (BGBl.I 2016, Nr. 12, S. 459)

1B-33 Gesetz über die Bereitstellung von Produkten auf dem Markt (**Produktsicherheitsgesetz** - ProdSG) vom 8. November 2011 (BGBl.I 2011, Nr. 57, S. 2178), das durch Artikel 435 der Verordnung vom 31. August 2015 (BGBl.I 2015, Nr. 35, S. 1474) geändert worden ist

- 14. ProdSV - **Druckgeräteverordnung** vom 27. September 2002 (BGBl.I 2002, Nr. 70, S. 3777), die zuletzt durch Artikel 24 des Gesetzes vom 8. November 2011 (BGBl.I 2011, Nr. 57, S. 2178) geändert worden ist, wird mit Wirkung vom 19. Juli 2016 ersetzt durch die 14. ProdSV - Druckgeräteverordnung vom 13. Mai 2015 (BGBl.I 2015, Nr. 18, S. 692), die durch Artikel 2 der Verordnung vom 6. April 2016 (BGBl.I 2016, Nr. 15, S. 597) geändert worden ist
  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 Verwendung von Arbeitsmitteln (**Betriebssicherheitsverordnung** - BetrSichV) vom 3. Februar 2015 (BGBl.I 2015, Nr. 4, S. 49), die durch Artikel 1 der Verordnung vom 13. Juli 2015 (BGBl.I 2015, Nr. 29, S. 1187) geändert worden ist

1B-37.1 DGUV Vorschrift 32 - **Kernkraftwerke** (bisher BGV C16, vorher VGB30) vom 1. Januar 1987 in der Fassung vom 1. Januar 1997 und
DGUV Vorschrift 32 DA - **Durchführungsanweisungen zur Unfallverhütungsvorschrift Kernkraftwerke** (bisher: BGV C16 DA) vom Januar 1987

1B-38 Gesetz über Betriebsärzte, Sicherheitsingenieure und andere Fachkräfte für **Arbeitssicherheit** - ASiG - vom 12. Dezember 1973 (BGBl.I 1973, Nr. 105, S. 1885), das zuletzt durch Artikel 3 Absatz 5 des Gesetzes vom 20. April 2013 (BGBl.I 2013, Nr. 20, S. 868) geändert worden ist

1B-39 **Lebensmittel-, Bedarfsgegenstände- und Futtermittelgesetzbuch** - LFGB - in der Fassung der Bekanntmachung vom 3. Juni 2013 (BGBl.I 2013, Nr. 27, S. 1426), das zuletzt durch Artikel 1 der Verordnung vom 26. Januar 2016 (BGBl.I 2016, Nr. 4, S. 108) geändert worden ist

1B-40 Gesetz über Tabakerzeugnisse und verwandte Erzeugnisse (**Tabakerzeugnisgesetz** - TabakerzG) vom 4. April 2016 (BGBl.I 2016, Nr. 15, S. 569)

1B-41 **Bedarfsgegenständeverordnung** - BedGgstV - in der Fassung der Bekanntmachung vom 23. Dezember 1997 (BGBl.I 1998, Nr. 1, S. 5), die zuletzt durch Artikel 2 des Gesetzes vom 15. Februar 2016 (BGBl.I 2016, Nr. 8, S. 198) geändert worden ist

1B-42.1 **Informationsfreiheitsgesetz** - IFG - vom 5. September 2005 (BGBl.I 2005, Nr. 57, S. 2722), das durch Artikel 2 Absatz 6 des Gesetzes vom 7. August 2013 (BGBl.I 2013, Nr. 48, S. 3154) geändert worden ist

1B-42.2 **Informationsgebührenverordnung** - IFGGebV - vom 2. Januar 2006 (BGBl.I 2006, Nr.1, S. 6) , die durch Artikel 2 Absatz 7 des Gesetzes vom 7. August 2013 (BGBl.I 2013, Nr. 48, S. 3154) geändert worden ist

1B-44 Gesetz über ergänzende Vorschriften zu Rechtsbehelfen in Umweltangelegenheiten nach der EG-Richtlinie 2003/35/EG (**Umwelt-Rechtsbehelfsgesetz** - UmwRG) in der Fassung der Bekanntmachung vom 8. April 2013 (BGBl.I 2013, Nr. 17, S. 753), das zuletzt durch Artikel 1 des Gesetzes vom 20. November 2015 (BGBl.I 2015, Nr. 47, S. 2069) geändert worden ist

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), das zuletzt durch Artikel 2 des Gesetzes vom 29. Juli 2009 (BGBl.I 2009, Nr. 49, S. 2350) geändert worden ist

1B-46.1 Verordnung über die **Berufsausbildung zur Fachkraft für Schutz und Sicherheit** - SchSiAusbV 2008 - 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), die zuletzt durch Artikel 44 der Verordnung vom 26. März 2014 (BGBl.I 2014, Nr. 12, S. 274) geändert worden ist

1E Multilaterale Vereinbarungen über nukleare Sicherheit und Strahlenschutz mit nationalen Ausführungsvorschriften

1E-1 Allgemeines

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, in Kraft seit 26. August 2014
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
in Kraft für Deutschland seit 15. April 2007 (BGBl.II 2007, Nr. 27, S. 1392)
Gesetz dazu (**Informationsfreiheitsgesetz**) vom 5. September 2005 (BGBl.I 2005, Nr. 57, S. 2722), das durch Artikel 2 Absatz 6 des Gesetzes vom 7. August 2013 (BGBl.I 2013, Nr. 48, S. 3154) geändert worden ist
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 9. Oktober 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 Nukleare Sicherheit und Strahlenschutz

1E-2.1 **Übereinkommen über nukleare Sicherheit** (Convention on Nuclear Safety - CNS, INFCIRC/449) vom 17. Juni 1994, in Kraft seit 24. Oktober 1996
Gesetz dazu vom 7. Januar 1997 (BGBl.II 1997, Nr. 2, S. 130)
in Kraft für Deutschland seit 20. April 1997 (BGBl.II 1997, Nr. 14, S. 796)

1E-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), tritt am 8. Mai 2016 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, in Kraft seit 22. Juli 1959
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. Juli 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), s. auch EURATOM-Grundnorm;
wurden 1981 ersetzt durch “Basic Safety Standards for Radiation Protection”

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

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 1. August 1991 (BGBl.I 1995, Nr. 24, S. 657)
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, in Kraft seit 15. April 2015

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 zur Gründung der **Europäischen Atomgemeinschaft EURATOM** vom 25. März 1957 (BGBl.II 1957, S. 1014, berichtigt S. 1678; berichtigt BGBl. II 1999 S. 1024
konsolidierte Fassung 2015 vom Internetportal des Rates
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-Vertrags 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), geändert, konsolidierte Fassung 2013

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)), geändert, konsolidierte Fassung 2004

1F-1.5 Empfehlung 2010/635/EURATOM der Kommission vom 11. Oktober 2010 zur **Anwendung des Artikels 37** des EURATOM-Vertrags (ABl. 2010, L 279)

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, L138), geändert, 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), geändert, letzte konsolidierte Fassung 2013

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) 237/2014 des Rates vom 13. Dezember 2013 zur Schaffung eines **Instruments für Zusammenarbeit im Bereich der nuklearen Sicherheit** (ABl. 2014, L 77), gültig bis 31. Dezember 2020

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 2011/92/EU des EP und des Rates über die **Umweltverträglichkeitsprüfung** bei bestimmten öffentlichen und privaten Projekten vom 13. Dezember 2011 (ABl. 2012, L 26), geändert, letzte konsolidierte Fassung 2014
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-1.18.1 Verordnung (EG) 1221/2009 des EP und des Rates vom 25. November 2009 über die freiwillige Beteiligung von Organisationen an einem **Gemeinschaftssystem für das Umweltmanagement und die Umweltbetriebsprüfung** - EMAS (ABl. 2009, L 342), geändert, konsolidierte Fassung 2013

1F-1.18.2 Beschluss (EU) 2015/801 der Kommission vom 20. Mai 2015 über das **Referenzdokument** über bewährte Praktiken im Umweltmanagement, branchenspezifische einschlägige Indikatoren für die Umweltleistung und Leistungsrichtwerte für den Einzelhandel gemäß der Verordnung (EG) Nr. 1221/2009 des Europäischen Parlaments und des Rates über die freiwillige Teilnahme von Organisationen an einem Gemeinschaftssystem für Umweltmanagement und Umweltbetriebsprüfung (ABl. 2015, L 127)

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 2015

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, geändert zum 1. Januar 2016 durch Verordnung (EU) 167/2013 des Europäischen Parlaments und des Rates vom 5. Februar 2013 (ABl. 2013, L 60), zuletzt geändert durch Richtlinie 2014/33/EU des Europäischen Parlamentes und des Rates vom 26. Februar 2014 (ABl. 2014, L 96)

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)), zuletzt geändert durch die Richtlinie des Rates 2014/87/EURTOM vom 8. Juli 2014 (ABl. 2014, L 219), konsolidierte Fassung 2014

1F-1.26 Empfehlung (Euratom) 2016/538 der Kommission vom 4. April 2016 über die Anwendung des Artikels 103 des Euratom Vertrags (ABl, 2016, L 89)
Hinweis: *Artikel 103 ist relevant, um die Einheitlichkeit und den Vorrang des Euratom-Rechts mit der Handlungsfreiheit der Mitgliedstaaten im Bereich der Außenbeziehungen im Nuklearbereich in Einklang zu bringen*

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)
Hinweis: *wird ab 6. Februar 2018 aufgehoben durch Richtlinie 2013/59/EURATOM des Rates vom 5. Dezember 2013 zur Festlegung grundlegender Sicherheitsnormen für den Schutz vor den Gefahren einer Exposition gegenüber ionisierender Strahlung (ABl. 2014, L 13); Berichtigung der Richtlinie 2013/59/EURATOM vom 17. März 2016 (ABl. 2016, L 72)*

1F-2.2 Richtlinie 2003/122/EURATOM des Rates vom 22. Dezember 2003 zur **Kontrolle hochradioaktiver Strahlenquellen** und **herrenloser Strahlenquellen** (ABl. 2003, L 346)
Hinweis: *wird ab 6. Februar 2018 aufgehoben durch Richtlinie 2013/59/EURATOM*

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)
Hinweis: *wird ab 6. Februar 2018 aufgehoben durch Richtlinie 2013/59/EURATOM*

1F-2.4 Richtlinie 94/33/EG des Rates vom 22. Juni 1994 über **Jugendarbeitsschutz** (ABl. 1994, L 216), mehrfach geändert, letzte konsolidierte Fassung 2014

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), mehrfach geändert, letzte konsolidierte Fassung 2015, Berichtigung der Delegierten Verordnung (EU) 2015/2420 vom 5. März 2016 (ABl. 2016, L 60)

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. 1999, 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), berichtigt am 23. Dezember 2011 (ABl. 2011, L 343)
- 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-3.19 Richtlinie 2011/70/EURATOM des Rates vom 19. Juli 2011 über einen **Gemeinschaftsrahmen für die verantwortungsvolle und sichere Entsorgung abgebrannter Brennelemente und radioaktiver Abfälle** (ABl. 2011, L 199)

1F-3.20 Verordnung (EURATOM) 1368/2013 des Rates vom 13. Dezember 2013 über die **Unterstützung der Hilfsprogramme für die Stilllegung kerntechnischer Anlagen in Bulgarien und der Slowakei** durch die Union (ABl. 2013, L 346)

1F-3.21 Verordnung (EURATOM) 1369/2013 des Rates vom 13. Dezember 2013 über die **Unterstützung des Hilfsprogramms für die Stilllegung kerntechnischer Anlagen in Litauen** durch die Union (ABl. 2013, L 356)

1F-4 Radiological emergencies

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)
Hinweis: *wird ab 6. Februar 2018 aufgehoben durch Richtlinie 2013/59/EURATOM*

1F-4.7 Beschluss 1313/2013/EU des Europäischen Parlaments und des Rates vom 17. Dezember 2013 über **ein Katastrophenschutzverfahren der Union** (ABl. 2013, L 347)

- **Durchführungsbeschluss** der Kommission vom 16. Oktober 2014 zur Festlegung von Vorschriften für die Durchführung des Beschlusses 1313/2013/EU (ABl. 2014, L 320)

1F-4.8 Verordnung (Euratom) 2016/52 des Rates vom 15. Januar 2016 zur Festlegung von **Höchstwerten an Radioaktivität** in Lebens- und Futtermitteln im Falle eines nuklearen Unfalls oder eines anderen radiologischen Notfalls (ABl. 2016, L 13)

1F-4.9 Verordnung (EWG) 2219/89 des Rates vom 18. Juli 1989 über besondere Bedingungen für die **Ausfuhr von Nahrungsmitteln und Futtermitteln** im Falle **eines nuklearen Unfalls** oder einer **anderen radiologischen Notstandssituation** (ABl. 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** des Rates über die Einfuhrbedingungen für landwirtschaftliche Erzeugnisse in Drittländern nach dem Unfall im Kernkraftwerk Tschernobyl (ABl. 2006, L 306), geändert, konsolidierte Fassung 2013

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)

1F-4.11 Durchführungsverordnung (EU) 2016/6 der Kommission vom 5. Januar 2016 mit **Bedingungen für die Einfuhr von Lebens- und Futtermitteln**, deren Ursprung oder Herkunft Japan ist, **nach dem Unfall im Kernkraftwerk Fukushima** (ABl. 2016, L 3)

2 General administrative provisions

2-1 Allgemeine Verwaltungsvorschrift zu § 47 Strahlenschutzverordnung (**Ermittlung der Strahlenexposition durch die Ableitung** radioaktiver Stoffe aus Anlagen oder Einrichtungen) vom 28. August 2012 (BAnz. AT 05.09.2012 B1)

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 Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety and the formerly competent Ministry of the Interior

3-0.1 **Sicherheitsanforderungen an Kernkraftwerke** in der Fassung der Bekanntmachung vom 3. März 2015 (BAnz AT 30.03.2015 B2)

3-0.2 **Interpretationen zu den Sicherheitsanforderungen** an Kernkraftwerke vom 22. November 2012 vom 29. November 2013 (BAnz AT 10.12.2013 B4), geändert am 3. März 2015 (BAnz AT 30.03.2015 B3)

3-1 **Sicherheitskriterien für Kernkraftwerke** vom 21. Oktober 1977 (BAnz. 1977, Nr. 206), fortgeschrieben und abgelöst durch Sicherheitsanforderungen an Kernkraftwerke vom 3. März 2015 und die Interpretationen hierzu vom 29. November 2013, die am 3. März 2015 geändert wurden (vgl. 3-0.1 und 3-0.2)

3-2 Richtlinie für den **Fachkundenachweis von Kernkraftwerkspersonal** vom 24. Mai 2012 (GMBl. 2012, Nr. 34, S. 611)
Anpassung Fachkundenachweis von Kernkraftwerkspersonal in Kernkraftwerken ohne Berechtigung zum Leistungsbetrieb, RdSchr. d. BMU vom 21. Mai 2013 (Aktenzeichen RS I 6 - 13831-1/1 und 13831-1/2) mit Anlage 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 30. März 2015 (GMBl. 2015, Nr. 16, S. 306)

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)

3-15.2 **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)

3-22 **Merkpostenliste für die Durchführung einer Bewertung des aktuellen Sicherheitsstatus der Anlage für die Nachbetriebsphase** mit Anschreiben des BMUB vom 2. Oktober 2014

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), geändert am 7. September 2012 (GMBl. 2012, Nr. 47/48, S. 919)

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)

3-33.1 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), fortgeschrieben und abgelöst durch Sicherheitsanforderungen an Kernkraftwerke vom 3. März 2015 und die Interpretationen hierzu vom 29. November 2013, die am 3. März 2015 geändert wurden (vgl. 3-0.1 und 3-0.2)

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)

3-36 Berechnungsgrundlage zur Ermittlung der Strahlenexposition infolge von Störmaßnahmen oder sonstiger Einwirkungen Dritter (SEWD) auf kerntechnische Anlagen und Einrichtungen - **SEWD-Berechnungsgrundlage** vom 28. Oktober 2014 (GMBl. 2014, Nr. 64, S. 1315)

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 zur **Erhaltung der Fachkunde des verantwortlichen Kernkraftwerkspersonals** vom 17. Juli 2013 (GMBl. 2013, Nr. 36, S. 712)
Anpassung Erhaltung der Fachkunde des Kernkraftwerkspersonals in Kernkraftwerken ohne Berechtigung zum Leistungsbetrieb, RdSchr. d. BMUB vom 23. Januar 2014 (Aktenzeichen RS I 6 - 13831-1/3) mit Anlage

3-39 **Richtlinie für den Inhalt der Fachkundeprüfung** vom 24. Mai 2012 (GMBl. 2012, Nr. 30, S. 905)
Anpassung Inhalt der Fachkundeprüfung des Kernkraftwerkspersonals in Kernkraftwerken ohne Berechtigung zum Leistungsbetrieb, RdSchr. d. BMU vom 21. Mai 2013 (Aktenzeichen RS I 6 - 13831-1/1 und 13831-1/2) mit Anlage 2

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)

3-47 Genehmigungen gemäß § 20 Strahlenschutzverordnung (**Mustergenehmigung für genehmigungspflichtige Tätigkeiten in fremden Anlagen oder Einrichtungen**) vom 21. September 1990 und vom 2. November 1990 (GMBl. 1990, Nr. 33, S. 848)

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), fortgeschrieben und abgelöst durch Sicherheitsanforderungen an Kernkraftwerke vom 3. März 2015 und die Interpretationen hierzu vom 29. November 2013, die am 3. März 2015 geändert wurden (vgl. 3-0.1 und 3-0.2)

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
fortgeschrieben und abgelöst durch Sicherheitsanforderungen an Kernkraftwerke vom 3. März 2015 und die Interpretationen hierzu vom 29. November 2013, die am 3. März 2015 geändert wurden (vgl. 3-0.1 und 3-0.2)

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
fortgeschrieben und abgelöst durch Sicherheitsanforderungen an Kernkraftwerke vom 3. März 2015 und die Interpretationen hierzu vom 29. November 2013, die am 3. März 2015 geändert wurden (vgl. 3-0.1 und 3-0.2)

3-52.1
- **Erläuterungen zu den Meldekriterien für meldepflichtige Ereignisse gemäß Anlage 1** der AtSMV (Stand: 09/2015)
- **Erläuterungen zu den Meldekriterien für Meldepflichtige Ereignisse gemäß Anlage 2** der AtSMV (Stand 11/2007)
- **Erläuterungen zu den Meldekriterien für Meldepflichtige Ereignisse gemäß Anlage 3** der AtSMV (Stand 03/2007)
- **Erläuterungen zu den Meldekriterien für Meldepflichtige Ereignisse gemäß Anlage 4** der AtSMV (Stand 04/2007)
- **Erläuterungen zu den Meldekriterien für Meldepflichtige Ereignisse gemäß Anlage 5** der AtSMV (Stand 04/2013)
- Zusammenstellung von in den Meldekriterien der AtSMV verwendeten **Begriffen** (Stand: 04/2015)

3-52.2 **Meldung eines meldepflichtigen Ereignisses in Anlagen nach § 7 AtG zur Spaltung von Kernbrennstoffen** (Meldeformular, Stand: 04/08)

3-52.3 **Meldung eines meldepflichtigen Ereignisses in Anlagen nach § 7 AtG der Kernbrennstoffver- und -entsorgung** (Meldeformular, Stand: 04/08)

3-52.4 **Meldung eines meldepflichtigen Ereignisses bei der Aufbewahrung von Kernbrennstoffen und verfestigten hochradioaktiven Spaltproduktlösungen nach § 6 AtG** (Meldeformular, Stand: 04/08)

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)

3-56 Bekanntmachung über die Anwendung der deutschen Fassung der Internationalen Nuklearen und Radiologischen Ereignis-Skala (INES) in kerntechnischen Einrichtungen sowie im Strahlenschutz außerhalb der Kerntechnik - **Deutsches INES-Handbuch** vom 20. Februar 2015 (BAnz AT 30.03.2015 B1)

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. Dezember 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 Anlagen zur Spaltung von Kernbrennstoffen vom 20. Februar 2014 (GMBl. 2014, Nr. 13, S. 289)

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 19. November 2014

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

3-99 Bekanntmachung zu der “Richtlinie für den Schutz von IT-Systemen in kerntechnischen Anlagen und Einrichtungen der Sicherungs-kategorien I und II gegen Störmaßnahmen oder sonstige Einwirkungen Dritter (**SEWD-Richtlinie IT**)”, zu den “Lastannahmen zur Auslegung kerntechnischer Anlagen und Einrichtungen gegen Störmaßnahmen oder sonstige Einwirkungen Dritter mittels IT-Angriffen (**IT-Lastannahmen**)” und zu den “Erläuterungen für die Zuordnung der IT-Systeme von Kernkraftwerken zu IT-Schutzbedarfsklassen (**Erläuterungen**)” vom 8. Juli 2013 (GMBl. 2013, Nr. 36, S. 711) (ohne Wortlaut)

4 Other provisions and recommendations relevant for the nuclear rules and regulations, including selected recommendations of the RSK and the SSK

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)

4-2 **Kriterien für die Alarmierung der Katastrophenschutzbehörde** durch die Betreiber kerntechnischer Einrichtungen
Gemeinsame Stellungnahme der Strahlenschutzkommission und der Reaktor-Sicherheitskommission mit Ergänzungen
verabschiedet auf der 186. Sitzung der SSK am 11./12.09.2003, Ergänzung verabschiedet in der 260. Sitzung der SSK am 28.02.2013
verabschiedet auf der 366. Sitzung der RSK am 16.10.2003, Ergänzung verabschiedet in der 453. Sitzung der RSK am 28.02.2013
BAnz AT 09.10.2014 B1

4-3 Übersicht über **Maßnahmen zur Verringerung der Strahlenexposition nach Ereignissen mit nicht unerheblichen radiologischen Auswirkungen** (Maßnahmenkatalog),
Teil 1: Auswahl von Maßnahmen
Teil 2: Hintergrundinformationen, Theorie und Anwendungsbeispiele
Teil 3: Behandlung und Entsorgung kontaminierter landwirtschaftlicher Produkte
verabschiedet in der der 200. Sitzung der SSK am 30.06./01.07.2005
Überarbeitung des Maßnahmenkatalogs 1 und 2 sowie Integrierung des Teils 3
verabschiedet in der 220. Sitzung der SSK am 05./06.12.2007
veröffentlicht in der Reihe “Berichte der Strahlenschutzkommission”, Heft 60 (2010)

4-4 **Leitfaden für den Fachberater Strahlenschutz der Katastrophenschutzleitung** bei kerntechnischen Unfällen
Stellungnahme der Strahlenschutzkommission
verabschiedet in der 182. Sitzung der SSK am 04.-06.12.2002
veröffentlicht in der Reihe “Berichte der Strahlenschutzkommission”, Heft 37 (2004)

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 (2004)

4-5 **Feuerwehrdienstvorschrift FwDV 500 “Einheiten im ABC-Einsatz”**, Stand: 2012
Die FwDV 500 wurde am 29.02./01.03.2012 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: 01/2012

4-6 **Leitfaden Polizei LF 450 “Gefahren durch chemische, radioaktive und biologische Stoffe”** Ausgabe 2006
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, urn:nbn:de:0221-201011243824
Daten zur probabilistischen Sicherheitsanalyse für Kernkraftwerke, BfS-SCHR-38/05, urn:nbn:de:0221-2010112433838
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 DeutschlandRadio 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 **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
BBK: Notfall- und KatastrophenPharmazie - Band 1: Bevölkerungsschutz und Medizinische Notfallversorgung
BBK: Notfall- und KatastrophenPharmazie - Band 2: Pharmazeutisches Notfallmanagement
herausgegeben vom Bundesamt für Bevölkerungsschutz und Katastrophenhilfe (BBK) und der Deutschen Gesellschaft für KatastrophenMedizin e.V. (DGKM e.V.)

4-12 **Radiologische Grundlagen für Entscheidungen über Maßnahmen zum Schutz der Bevölkerung bei Ereignissen mit Freisetzungen von Radionukliden**
Empfehlung der Strahlenschutzkommission
verabschiedet in der 268. Sitzung der SSK am 13./14. Februar 2014
BAnz AT 18.11.2014 B5

4-13 **Rahmenempfehlungen für die Planung von Notfallschutzmaßnahmen durch Betreiber von Kernkraftwerken**
Empfehlung der Strahlenschutzkommission und der Reaktor-Sicherheitskommission
verabschiedet in der 242. Sitzung der SSK am 01./02. Juli 2010, Ergänzung verabschiedet in der 271. Sitzung der SSK am 21. Oktober 2014
verabschiedet in der 429. Sitzung der RSK am 14. Oktober 2010, Ergänzung verabschiedet in der 468. Sitzung der RSK am 04. September 2014
BAnz AT 13.05.2015 B5

4-14 **Verwendung von Jodtabletten zur Jodblockade der Schilddrüse bei einem kerntechnischen Unfall**
Empfehlung der Strahlenschutzkommission
verabschiedet in der 247. Sitzung der SSK am 24./25. Februar 2011
BAnz. 2011, Nr. 135

4-15 **Regelungen zu Anlagenzuständen nach Eintritt eines Störfalls**
Empfehlung der Reaktor-Sicherheitskommission
verabschiedet in der 439. Sitzung der RSK am 7. Juli 2011
BAnz. 2011, Nr. 185

4-16 **RSK-Verständnis der Sicherheitsphilosophie**
Stellungnahme der Reaktor-Sicherheitskommission
verabschiedet in der 460. Sitzung der RSK am 29. August 2013
BAnz AT 05.12.2013 B4

4-17 **Fragestellungen zu Aufbau und Betrieb von Notfallstationen**
Empfehlung der Strahlenschutzkommission
verabschiedet in der 268. Sitzung der SSK am 13./14. Februar 2014
BAnz AT 21.05.2014 B3

4-18 **Planungsgebiete für den Notfallschutz in der Umgebung von Kernkraftwerken**
Empfehlung der Strahlenschutzkommission
verabschiedet in der 268. Sitzung der SSK am 13./14. Februar 2014
BAnz AT 21.05.2014 B4

4-19 **Planung der Iodblockade in der Umgebung stillgelegter Kernkraftwerke**
Empfehlung der Strahlenschutzkommission
verabschiedet in der 269. Sitzung der SSK am 10. April 2014
BAnz AT 05.11.2014 B3

4-20 **Prognose und Abschätzung von Quelltermen bei Kernkraftwerksunfällen**
Empfehlung der Strahlenschutzkommission
verabschiedet in der 270. Sitzung der SSK am 17./18. Juli 2014
BAnz AT 06.03.2015 B5

4-21 **Planungsgebiete für den Notfallschutz in der Umgebung stillgelegter Kernkraftwerke**
Empfehlung der Strahlenschutzkommission
verabschiedet in der 270. Sitzung der SSK am 17./18. Juli 2014
BAnz AT 06.03.2015 B5

4-22 **Rahmenempfehlungen für den Katastrophenschutz in der Umgebung kerntechnischer Anlagen**
Empfehlung der Strahlenschutzkommission
verabschiedet in der 274. Sitzung der SSK am 19./20. Februar 2015
BAnz AT 04.01.2016 B4

5 Standards of the Nuclear Safety Standards Commission (KTA), as at 11 May 2016

Standard No. KTA	Title	Issue	Publication in *Bundesanzeiger* No.	of	Earlier issues	Reaffirmed	Engl. translations
KTA-interne Verfahrensregeln *(KTA-internal procedural rules)*							
Begriffe und Definitionen (Begriffe-Sammlung KTA-GS-12) *(KTA Collection of definitions)*		2015-07	-	-	1991-06 1996-01 2004-01 2006-01 2007-01 2008-01 2009-01 2010-01 2011-01 2012-01 2013-01	-	-
1200 Allgemeines, Administration, Organisation *(General, administration, organisation)*							
1201	Anforderungen an das Betriebshandbuch *Requirements for the Operating Manual*	2015-11	29.04.2016 (nach Abschn. 5.3 Verf.O.)		1978-02 1981-03 1985-12 1998-06 2009-11	-	-
1202	Anforderungen an das Prüfhandbuch *Requirements for the Testing Manual*	2009-11	3 a	07.01.10	1984-06	11.11.14	**1202**
1203	Anforderungen an das Notfallhandbuch *Requirements for the Emergency Manual*	2009-11	3 a	07.01.10	-	10.11.15	**1203**
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*	2012-11		23.01.13	1984-11	-	**1301.1***
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*	2014-11		15.01.15	1982-06 1989-06 2008-11	-	**1301.2**
1400 Qualitätssicherung *(Quality assurance)*							
1401	Allgemeine Forderungen an die Qualitätssicherung *General Requirements Regarding Quality Assurance*	2013-11		17.01.14	1980-02 1987-12 1996-06	19.06.01	**1401**
1402	Integriertes Managementsystem zum sicheren Betrieb von Kernkraftwerken *Integrated Management System for the Safe Operation of Nuclear Power Plants*	2012-11		23.01.13	-	-	**1402**
1403*	Alterungsmanagement in Kernkraftwerken *Ageing Management in Nuclear Power Plants*	2010-11	199 a	31.12.10	-	-	**1403***

Standard No. KTA	Title	Issue	Publication in *Bundesanzeiger* No.	of	Earlier issues	Reaffirmed	Engl. translations
1404	Dokumentation beim Bau und Betrieb von Kernkraftwerken *Documentation During the Construction and Operation of Nuclear Power Plants*	2013-11		17.01.14	1989-06 2001-06	-	**1404**
1408.1	Qualitätssicherung von Schweißzusätzen und -hilfsstoffen für druck- und aktivitätsführende 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*	2015-11		08.01.16	1985-06 2008-11	-	**1408.1**
1408.2	Qualitätssicherung von Schweißzusätzen und -hilfsstoffen für druck- und aktivitätsführende 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*	2015-11		08.01.16	1985-06 2008-11	-	**1408.2**
1408.3	Qualitätssicherung von Schweißzusätzen und -hilfsstoffen für druck- und aktivitätsführende 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*	2015-11		08.01.16	1985-06 2008-11	-	**1408.3**
1500 Strahlenschutz und Überwachung *(Radiological protection and monitoring)*							
1501*	Ortsfestes System zur Überwachung von Ortsdosisleistungen innerhalb von Kernkraftwerken *Stationary System for Monitoring the Local Dose Rate within Nuclear Power Plants*	2010-11	199 a	31.12.10	1977-10 1991-06 2004-11	-	**1501***
1502*	Überwachung der Radioaktivität in der Raumluft von Kernkraftwerken *Monitoring Radioactivity in the Inner Atmosphere of Nuclear Power Plants*	2013-11		17.01.14	1986-06 (1502.1) 2005-11	-	**1502***
(1502.2)	Überwachung der Radioaktivität in der Raumluft von Kernkraftwerken; Teil 2: Kernkraftwerke mit Hochtemperaturreaktor *Monitoring Radioactivity in the Inner Atmosphere of Nuclear Power Plants; Part 2: Nuclear Power Plants with High Temperature Reactors*	1989-06	229 a	07.12.89	-	-	(1502.2)

Standard No. KTA	Title	Issue	Publication in *Bundesanzeiger* No.	 of	Earlier issues	Reaffirmed	Engl. translations
1503.1*	Überwachung der Ableitung gasförmiger und an Schwebstoffen gebundener radioaktiver Stoffe; Teil 1: Überwachung der Ableitung radioaktiver 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*	2013-11		17.01.14	1979-02 1993-06 2002-06	-	**1503.1***
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*	2013-11		17.01.14	1999-06	-	**1503.2***
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*	2013-11		17.01.14	1999-06	-	**1503.3***
1504	Überwachung der Ableitung radioaktiver Stoffe mit Wasser *Monitoring and Assessing of the Discharge of Radioactive Substances in Liquid Effluents*	2015-11		08.01.16	1978-06 1994-06 2007-11	-	**1504**
1505*	Nachweis der Eignung von festinstallierten Messeinrichtungen zur Strahlungsüberwachung *Certification of Suitability of Permanently Installed Measuring Equipment for Radiation Monitoring*	2011-11	11	19.01.12	2003-11	-	**1505***
[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)*	1986-06	162 a Correction 229	03.09.86 10.12.86	-	16.11.04 withdrawn	[1506]
1507*	Überwachung der Ableitungen radioaktiver Stoffe bei Forschungsreaktoren *Monitoring the Discharge of Radioactive Substances from Research Reactors*	2012-11		23.01.13	1984-03 1998-06	-	**1507***
1508*	Instrumentierung zur Ermittlung der Ausbreitung radioaktiver Stoffe in der Atmosphäre *Instrumentation for Determining the Dispersion of Radioactive Substances in the Atmosphere*	2006-11	245 b	30.12.06	1988-09	15.11.11	**1508***

Standard No. KTA	Title	Issue	Publication in *Bundesanzeiger* No.	of	Earlier issues	Reaffirmed	Engl. translations
2100 Gesamtanlage *(Plant)*							
2101.1	Brandschutz in Kernkraftwerken; Teil 1: Grundsätze des Brandschutzes *Fire Protection in Nuclear Power Plants; Part 1: Basic Requirements*	2015-11		08.01.16	1985-12 2000-12	-	**2101.1**
2101.2	Brandschutz in Kernkraftwerken; Teil 2: Brandschutz an baulichen Anlagen *Fire Protection in Nuclear Power Plants; Part 2: Fire Protection of Structural Components*	2015-11		08.01.16	2000-12	-	**2101.2**
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*	2015-11		08.01.16	2000-12	-	**2101.3**
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)*	2015-11		08.01.16	1989-06 2000-06	-	**2103**
2200 Einwirkungen von außen *(External hazards)*							
2201.1	Auslegung von Kernkraftwerken gegen seismische Einwirkungen; Teil 1: Grundsätze *Design of Nuclear Power Plants against Seismic Events; Part 1: Principles*	2011-11	11	19.01.12	1975-06 1990-06	-	**2201.1**
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)*	2012-11		23.01.13	1982-11 1990-06	-	**2201.2**
2201.3	Auslegung von Kernkraftwerken gegen seismische Einwirkungen; Teil 3: Bauliche Anlagen *Design of Nuclear Power Plants against Seismic Events; Part 2: Structural Components*	2013-11		17.01.14	-	-	**2201.3**
2201.4	Auslegung von Kernkraftwerken gegen seismische Einwirkungen; Teil 4: Anlagenteile *Design of Nuclear Power Plants against Seismic Events; Part 4: Components*	2012-11		23.01.13	1990-06	-	**2201.4**
2201.5	Auslegung von Kernkraftwerken gegen seismische Einwirkungen; Teil 5: Seismische Instrumentierung *Design of Nuclear Power Plants against Seismic Events; Part 5: Seismic Instrumentation*	2015-11		08.01.16	1977-06 1990-06 1996-06	-	**2201.5**

Standard No. KTA	Title	Issue	Publication in *Bundesanzeiger* No.	Publication in *Bundesanzeiger* of	Earlier issues	Reaffirmed	Engl. translations
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*	2015-11		08.01.16	1992-06	-	**2201.6**
2206	Auslegung von Kernkraftwerken gegen Blitzeinwirkungen *Design of Nuclear Power Plants Against Damaging Effects from Lightning*	2009-11	3 a	07.01.10	1992-06 2000-06	11.11.14	**2206**
2207	Schutz von Kernkraftwerken gegen Hochwasser *Flood Protection for Nuclear Power Plants*	2004-11	35 a	16.07.05	1982-06 1992-06	11.11.14	**2207**
2500 Bautechnik *(Civil engineering)*							
2501*	Bauwerksabdichtungen von Kernkraftwerken *Structural Waterproofing of Nuclear Power Plants*	2015-11	29.04.2016 (nach Abschn. 5.3 Verf.O.)		1988-09 2002-06 2011-04 2010-11	-	-
2502	Mechanische Auslegung von Brennelementlagerbecken in Kernkraftwerken mit Leichtwasserreaktoren *Mechanical Design of Fuel Assembly Storage Pools in Nuclear Power Plants with Light Water Reactors*	2011-11	11	19.01.12	1990-06	-	**2502**
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*	2012-11		23.01.13	1980-02	-	**3101.1**
3101.2	Auslegung der Reaktorkerne von Druck- und Siedewasserreaktoren; Teil 2: Neutronenphysikalische Anforderungen an Auslegung und Betrieb des Reaktorkerns 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*	2012-11		23.01.13	1987-12	-	**3101.2**
3101.3	Auslegung der Reaktorkerne von Druck- und Siedewasserreaktoren; Teil 3: Mechanische und thermische Auslegung *Design of Reactor Cores of Pressurized Water and Boiling Water Reactors;* *Part 3: Mechanical and Thermal Design*	2015-11		08.01.16	-	-	**3101.3**

Standard No. KTA	Title	Issue	Publication in *Bundesanzeiger* No.	of	Earlier issues	Reaffirmed	Engl. translations
(3102.1)	Auslegung der Reaktorkerne von gasgekühlten 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*	1978-06	189 a Beilage 23/78	06.10.78	-	15.06.93	(3102.1)
(3102.2)	Auslegung der Reaktorkerne von gasgekühlten Hochtemperaturreaktoren; Teil 2: Wärmeübergang im Kugelhaufen *Reactor Core Design for High Temperature Gas-Cooled Reactors;* *Part 2: Heat Transfer in Spherical Fuel Elements*	1983-06	194 Beilage 47/83	14.10.83	-	15.06.93	(3102.2)
(3102.3)	Auslegung der Reaktorkerne von gasgekühlten 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*	1983-03	136 a Beilage 24/81	28.07.81	-	15.06.93	(3102.3)
(3102.4)	Auslegung der Reaktorkerne von gasgekühlten Hochtemperaturreaktoren; Teil 4: Thermohydraulisches Berechnungsmodell 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*	1984-11	40 a Correction 124	27.02.85 07.07.89	-	15.06.93	(3102.4)
(3102.5)	Auslegung der Reaktorkerne von gasgekühlten 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*	1986-06	162 a	03.09.86	-	15.06.93	(3102.5)
3103	Abschaltsysteme von Leichtwasserreaktoren *Shutdown Systems for Light Water Reactors*	2015-11		08.01.16	1984-03	-	**3103**
(3104)	Ermittlung der Abschaltreaktivität *Determination of the Shutdown Reactivity*	1979-10	19 a Beilage 1/80	29.01.80	-	10.11.09	(3104)
3107	Anforderungen an die Kritikalitätssicherheit beim Brennelementwechsel *Nuclear Criticality Safety Requirements during Refuelling*	2014-11	15.01.15		-	-	**3107**

Standard No. KTA	Title	Issue	Publication in *Bundesanzeiger* No.	of	Earlier issues	Reaffirmed	Engl. translations
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*	*1998-06*	170 a	11.09.98	1979-02 1982-11 1990-06	11.11.03	**3201.1 ***
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*	2013-11	17.01.14		1980-10 1984-03 1996-06	-	**3201.2**
3201.3	Komponenten des Primärkreises von Leichtwasserreaktoren; Teil 3: Herstellung *Components of the Reactor Coolant Pressure Boundary of Light Water Reactors; Part 3: Manufacture*	2007-11	9 a Correction 82 a	17.01.08 05.06.09	1979-10 1987-12 1998-06	13.11.12	**3201.3**
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*	2010-11	199 a	31.12.10	1982-06 1990-06 1999-06	-	**3201.4***
3203	Überwachung des Bestrahlungsverhaltens von Werkstoffen der Reaktordruckbehälter von Leichtwasserreaktoren *Surveillance of the Irradiation Behaviour of Reactor Pressure Vessel Materials of LWR Facilities*	2001-06	235 a	15.12.01	1984-03	15.11.11	**3203**
3204	Reaktordruckbehälter-Einbauten *Reactor Pressure Vessel Internals*	2015-11	29.04.2016 (nach Abschn. 5.3 Verf.O.)		1984-03 1998-06 2008-11	-	-
3205.1 *	Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen; Teil 1: Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen für Primärkreiskomponenten 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*	2002-06	189 a	10.10.02	1982-06 1991-06	13.11.07	**3205.1 ***

Standard No. KTA	Title	Issue	Publication in *Bundesanzeiger*		Earlier issues	Reaffirmed	Engl. translations
			No.	of			
3205.2	Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen; Teil 2: Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen für druck- und aktivitätsführende Komponenten in Systemen 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*	2015-11	08.01.16		1990-06	-	**3205.2**
3205.3	Komponentenstützkonstruktionen mit nichtintegralen Anschlüssen; Teil 3: Serienmäßige Standardhalterungen *Component Support Structures with Non-integral Connections;* *Part 3: Series-Production Standard Supports*	2006-11	163 a	31.08.07	1998-06	15.11.11	**3205.3**
3206	Nachweise zum Bruchausschluss für druckführende Komponenten in Kernkraftwerken *Verification Analysis for Rupture Preclusion for Pressure Retaining Components in Nuclear Power Plants*	2014-11	15.01.15 Correction 26.11.15		-	-	-
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*	2015-11		26.11.15	1991-06 2000-06	-	**3211.1**
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*	2013-11		17.01.14	1992-06	-	**3211.2**
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*	2012-11		02.05.13 (nach Abschn. 5.3 Verf.O.)	1990-06 2003-11	-	**3211.3**
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*	2013-11		29.04.14 (nach Abschn. 5.3 Verf.O.)	1996-06 2012-11	-	**3211.4**
3300 Wärmeabfuhr *(Heat removal)*							

Standard No. KTA	Title	Issue	Publication in *Bundesanzeiger* No.	of	Earlier issues	Reaffirmed	Engl. translations
3301	Nachwärmeabfuhrsysteme von Leichtwasserreaktoren *Residual Heat Removal Systems of Light Water Reactors*	2015-11		08.01.16	1984-11	-	**3301**
3303	Wärmeabfuhrsysteme für Brennelementlagerbecken von Kernkraftwerken mit Leichtwasserreaktoren *Heat Removal Systems for Fuel Assembly Storage Pools in Nuclear Power Plants with Light Water Reactors*	2015-11		08.01.16	1990-06	-	**3303**
3400 Sicherheitseinschluss *(Containment)*							
3401.1 *	Reaktorsicherheitsbehälter aus Stahl; Teil 1: Werkstoffe *Steel Containment Vessels;* *Part 1: Materials*	1988-09	37 a	22.02.89	1980-06 1982-11	16.06.98	**3401.1 ***
3401.2 *	Reaktorsicherheitsbehälter aus Stahl; Teil 2: Auslegung, Konstruktion und Berechnung *Steel Containment Vessels;* *Part 2: Analysis and Design*	1985-06	203 a	29.10.85	1980-06	22.11.05	**3401.2 ***
3401.3 *	Reaktorsicherheitsbehälter aus Stahl; Teil 3: Herstellung *Steel Containment Vessels;* *Part 3: Manufacture*	1986-11	44 a	05.03.87	1979-10	10.06.97	**3401.3 ***
3401.4	Reaktorsicherheitsbehälter aus Stahl; Teil 4: Wiederkehrende Prüfungen *Steel Containment Vessels;* *Part 4: Inservice Inspections*	1991-06	7 a	11.01.92	1981-03	15.11.11	**3401.4**
3402	Schleusen am Reaktorsicherheitsbehälter von Kernkraftwerken – Personenschleusen *Airlocks Through the Containment Vessel of Nuclear Power Plants - Personnel Locks*	2014-11	06.05.15 (nach Abschn. 5.3 Verf.O.)		1976-11 2009-11	-	-
3403	Kabeldurchführungen im Reaktorsicherheitsbehälter von Kernkraftwerken *Cable Penetrations through the Reactor Containment Vessel*	2015-11	29.04.16 (nach Abschn. 5.3 Verf.O.)		1976-11 1980-10 2010-11	-	-
3404	Abschließung der den Reaktorsicherheitsbehälter durchdringenden Rohrleitungen von Betriebssystemen im Falle einer Freisetzung von radioaktiven Stoffen in den Reaktorsicherheitsbehälter *Isolation of Operating System Pipes Penetrating the Containment Vessel in the Case of a Release of Radioactive Substances into the Containment Vessel*	2013-11	29.04.14 (nach Abschn. 5.3 Verf.O.)		1988-09 2008-11	-	+
3405	Dichtheitsprüfung des Reaktorsicherheitsbehälters *Leakage Test of the Containment Vessel*	2015-11	29.04.16 (nach Abschn. 5.3 Verf.O.)		1979-02 2010-11	-	-

Standard No. KTA	Title	Issue	Publication in *Bundesanzeiger* No.	Publication in *Bundesanzeiger* of	Earlier issues	Reaffirmed	Engl. translations
3407	Rohrdurchführungen durch den Reaktorsicherheitsbehälter *Pipe Penetrations through the Reactor Containment Vessel*	2014-11		06.05.15 (nach Abschn. 5.3 Verf.O.)	1991-06	-	**3407**
3409	Schleusen am Reaktorsicherheitsbehälter von Kernkraftwerken – Materialschleusen *Airlocks for the Reactor Containment Vessel for Nuclear Power Plants - Material Locks*	2009-11	72 a	12.05.10	1979-06	11.11.14	**3409**
3413*	Ermittlung der Belastungen für die Auslegung des Volldrucksicherheitsbehälters gegen Störfälle innerhalb der Anlage *Determination of Loads for the Design of a Full Pressure Containment Vessel against Plant-Internal Incidents*	1989-06	229 a	07.12.89	-	11.11.14	**3413 ***
<u>3500 Instrumentierung und Reaktorschutz *(Instrumentation and reactor protection)*</u>							
3501	Reaktorschutzsystem und Überwachungseinrichtungen des Sicherheitssystems *Reactor Protection System and Monitoring Equipment of the Safety System*	2015-11		08.01.16	1977-03 1985-06	-	**3501**
3502	Störfallinstrumentierung *Accident Measuring Systems*	2012-11		23.01.13	1982-11 1984-11 1999-06	-	**3502**
3503	Typprüfung von elektrischen Baugruppen der Sicherheitsleittechnik *Type Testing of Electrical Modules for the Safety Related Instrumentation and Control System*	2015-11		08.01.16	1982-06 1986-11 2005-11	-	**3503**
3504	Elektrische Antriebe des Sicherheitssystems in Kernkraftwerken *Electrical Drive Mechanisms of the Safety System in Nuclear Power Plants*	2015-11	29.04.16 (nach Abschn. 5.3 Verf.O.)		1988-09 2006-11	15.11.11	-
3505	Typprüfung von Messwertgebern und Messumformern der Sicherheitsleittechnik *Type Testing of Measuring Sensors and Transducers of the Safety-Related Instrumentation and Control System*	2015-11		08.01.16	1984-11 2005-11	-	**3505**
3506	Systemprüfung der Sicherheitsleittechnik von Kernkraftwerken *Tests and Inspections of the Instrumentation and Control Equipment of the Safety System of Nuclear Power Plants*	2012-11		23.01.13	1984-11	-	**3506**
3507*	Werksprüfungen, Prüfungen nach Instandsetzung und Nachweis der Betriebsbewährung der Baugruppen und Geräte der Leittechnik 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*	2014-11		15.01.15	1986-11 2002-06	-	**3507 ***
<u>3600 Aktivitätskontrolle und –führung *(Activity control and activity management)*</u>							

Standard No. KTA	Title	Issue	Publication in *Bundesanzeiger* No.	of	Earlier issues	Reaffirmed	Engl. translations
3601*	Lüftungstechnische Anlagen in Kernkraftwerken *Ventilation Systems in Nuclear Power Plants*	2005-11	101 a	31.05.06	1990-06	16.11.10	**3601***
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*	2003-11	26 a	07.02.04	1982-06 1984-06 1990-06	19.11.13	**3602**
3603*	Anlagen zur Behandlung von radioaktiv kontaminiertem Wasser in Kernkraftwerken *Facilities for Treating Radioactively Contaminated Water in Nuclear Power Plants*	2009-11	3 a	07.01.10	1980-02 1991-06	11.11.14	**3603***
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)*	2005-11	101 a	31.05.06	1983-06	16.11.10	**3604***
3605*	Behandlung radioaktiv kontaminierter Gase in Kernkraftwerken mit Leichtwasserreaktoren *Treatment of Radioactively Contaminated Gases in Nuclear Power Plants with Light Water Reactors*	2012-11		23.01.13	1989-06	-	**3605***
3700 Energie- und Medienversorgung *(Energy and media supply)*							
3701	Übergeordnete Anforderungen an die elektrische Energieversorgung in Kernkraftwerken *General Requirements for the Electrical Power Supply in Nuclear Power Plants*	2014-11		15.01.15	3701.1 (1978-06) 3701.2 (1982-06) 1997-06 1999-06	-	**3701**
3702	Notstromerzeugungsanlagen mit Dieselaggregaten in Kernkraftwerken *Emergency Power Generating Facilities with Diesel-Generator Units in Nuclear Power Plants*	2014-11		15.01.15	3702.1 (1980-06) 3702.2 (1991-06) 2000-06	-	**3702**
3703	Notstromerzeugungsanlagen mit Batterien und Gleichrichtergeräten in Kernkraftwerken *Emergency Power Generating Facilities with Batteries and AC/DC Converters in Nuclear Power Plants*	2012-11		23.01.13	1986-06 1999-06	-	**3703**
3704	Notstromanlagen mit Gleichstrom-Wechselstrom-Umformern in Kernkraftwerken *Emergency Power Facilities with DC/AC Converters in Nuclear Power Plants*	2013-11		17.01.14	1984-06 1999-06	-	**3704**

Standard No. KTA	Title	Issue	Publication in *Bundesanzeiger*		Earlier issues	Reaffirmed	Engl. translations
			No.	of			
3705	Schaltanlagen, Transformatoren und Verteilungsnetze zur elektrischen Energieversorgung des Sicherheitssystems in Kernkraftwerken *Switchgear Facilities, Transformers and Distribution Networks for the Electrical Power Supply of the Safety System in Nuclear Power Plants*	2013-11	29.04.14 (nach Abschn. 5.3 Verf.O.)		1988-09 1999-06 2006-11	-	-
3706	Sicherstellung des Erhalts der Kühlmittelverlust-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*	2000-06	159 a	24.08.00	-	10.11.15	**3706**
<u>3900 Systeme, sonstige *(Other systems)*</u>							
3901	Kommunikationseinrichtungen für Kernkraftwerke *Communication Systems for Nuclear Power Plants*	2013-11		17.01.14	1977-03 1981-03 2004-11	-	**3901**
3902*	Auslegung von Hebezeugen in Kernkraftwerken *Design of Lifting Equipment in Nuclear Power Plants*	2012-11	Correction	23.01.13 02.05.13	1975-11 1978-06 1983-11 1992-06 1999-06	-	**3902 ***
3903 *	Prüfung und Betrieb von Hebezeugen in Kernkraftwerken *Inspection, Testing and Operation of Lifting Equipment in Nuclear Power Plants*	2012-11	Correction	23.01.13 02.05.13	1982-11 1993-06 1999-06	-	**3903 ***
3904	Warte, Notsteuerstelle und örtliche Leitstände in Kernkraftwerken *Control Room, Remote Shutdown Station and Local Control Stations in Nuclear Power Plants*	2007-11	9 a	17.01.08	1988-09	13.11.12	**3904**
3905 *	Lastanschlagpunkte an Lasten in Kernkraftwerken *Load Attaching Points on Loads in Nuclear Power Plants*	2012-11		23.01.13	1994-06 1999-06	-	**3905 ***

* Standard in revision

( ) in-active safety standard (safety standard no longer included in the reaffirmation process acc. sec. 5.2 of the procedural statutes)

[ ] withdrawn safety standard (safety standard withdrawn by decision of the KTA)

Appendix 6: Plant-specific activities and measures in German nuclear installations (extract from the National Action Plan)

Plants in power operation

Plant/ type	No.	Activity/measure	Related recommendation	Status	Finalisation
GKN II/ PWR	1	Battery capacities by plant design are higher than 10 h (BW[42] 1)	N-1	done	[43]
GKN II/ PWR	2	Obtaining and providing two mobile diesel generators at the site. Their operability was demonstrated in the 2012 refuelling outage. Technical description and procedures available. Studies of long-lasting loss of off-site power and resistance to external hazards have been submitted. The supervisory authority is in the act of checking whether further information is needed. (BW 2-3)	N-2, N-19	done	
GKN II/ PWR	3	An updated statement exists on fuel cooling. The multiple-cell coolers are the ultimate heat sink. The river Neckar is a diverse heat sink. The supervisory authority is in the act of checking whether further information is needed. (BW 5-6)	N-3, N-12	done	
GKN II/ PWR	4	A statement exists on fuel cooling. An additional option for injection into the component cooling system does not contribute meaningfully from a safety-related point of view due to the availability of the diverse heat sink. The RSK was asked for a supplementary statement. (BW 7-8)	N-4, N-12	in progress	2016
GKN II/ PWR	5	An assessment of reactor pressure vessel injection is available. The RSK was asked for a supplementary statement. (BW 4, 9)	N-5, N-20	in progress	2016
GKN II/ PWR	6	Possibility of filtered containment venting without electricity supply has been demonstrated. Additional studies into hydrogen propagation have been carried out. Studies into seismic safety have been presented. In this context, the recent RSK recommendations on hydrogen release of 15 April 2015 are also considered (N-25, N-26). Additional information necessary. (BW 17-18)	N-6, N-21, N-25, N-26	done in progress	 2016
GKN II/ PWR	7	Measure for injecting into the spent-fuel pool and operability demonstrated during 2012 refuelling outage, technical description and procedures have been prepared. (BW 11)	N-8	done	
GKN II/ PWR	8	The emergency measures to be considered can be initiated in case of a loss of the main control room either	N-9	done	

42 Numbers indicated refer to the serial number in the Action Plan of Baden-Wurttemberg (BW), as at 31 December 2015

43 All dates relating to the GKN I, GKN II, KKP 1 and KKP 2 nuclear power plants correspond to the Action Plan of Baden-Wurttemberg (BW), as at 31 December 2015

Plant/ type	No.	Activity/measure	Related rec-ommenda-tion	Status	Finalisation
		from the remote shutdown and control station or on site. The initiation criteria are discernible in the supplementary control room. (BW 19)			
GKN II/ PWR	9	Equal means of communication have been installed and are ready for operation. (BW 20)	N-10	done	
GKN II/ PWR	10	No generation of debris in the case of a design basis earthquake. Additional safety margins for the case of beyond-design earthquakes exist. Equipment for clearing debris is provided in diverse locations. Emergency protection measures are ensured. (BW 21)	N-11	done	
GKN II/ PWR	11	For the GKN II plant, no CCF potential for the loss of the circulating water return structures was identified. (BW 12)	N-12	done	
GKN II/ PWR	12	The reassessment of the ultimate and the diverse heat sink has been concluded with positive result. (BW 30)	N-12	done	
GKN II/ PWR	13	Additional assessment of the safety margins of the auxiliary service water and ventilation systems under extreme weather conditions. Supplementary requirements due to the RSK Statement of 6 November 2013. A statement by the operator is available. The supervisory authority is in the act of checking whether further information is needed. (BW 26)	N-13, N-24	done	
GKN II/ PWR	14	Specification of boundary conditions for ensuring the feasibility of emergency measures. For selected emergency procedures with special relevance (primary bleed, secondary bleed, filtered venting, external fuel pool injection and creation of a mobile emergency power supply), there was a positive assessment of the operability in the event of external design impacts.	N-13, N-18	done	
		A robustness analysis was performed and presented. Technical discussion on the robustness analysis necessary. (BW 13-15)		In progress	2016
GKN II/ PWR	15	Accessibility and safety under flooding conditions are ensured. (BW 24-25)	N-15	done	
GKN II/ PWR	16	Measures for spent fuel pool injection have been installed and their operability demonstrated during the 2012 outage. A technical description and procedure have been prepared. The operability of evaporation cooling has been demonstrated. (BW 10)	N-22	done	
GKN II/ PWR	17	Severe Accident Management Guidelines (SAMG) for power operation and for low-power and shutdown states have been prepared and implemented. (BW 16)	N-23	done	
KBR/ PWR	1	Preparation of a comprehensive and integrated concept for postulated station black-out (SBO) scenarios. The concept was prepared and contains i.a. the measures KBR/2, KBR/3 and KBR/4.	N-1, N-2, N-19	done	
KBR/ PWR	2	Establishment of connection points for connecting mobile emergency diesel genera-tors with protection against external hazards in the area of the emergency feedwater building and in the area of the 3rd grid con-	N-1, N-2, N-19	done	

Plant/ type	No.	Activity/measure	Related recommendation	Status	Finalisation
		nection.			
KBR/ PWR	3	Obtaining and providing a mobile emergency diesel generator for the supply of vital I&C installations, steam generator emergency feeding, and battery support. Design done and order placed, generator set has been delivered and installed.	N-1, N-19	done	
KBR/ PWR	4	Obtaining and providing a mobile emergency diesel generator in the long-term range to supply an emergency RHR chain. Design done and order placed, generator set has been delivered and installed.	N-2, N-19	done	
KBR/ PWR	5	Development of an emergency measure for injecting coolant into the component cooling system to cool the reactor pressure vessel and the spent fuel pool in case of a loss of the ultimate heat sink (emergency measure “mobile shortened residual-heat removal chain” developed).	N-3, N-4	done	
KBR/ PWR	6	Creation of a diverse source of cooling water (water intake from a source other than the river).	N-3, N-12	done	
KBR/ PWR	7	Obtaining and providing mobile pumps as well as other injection equipment. Equipment for pumping over fuel, electrical pump for steam generator feeding available, injection equipment for mobile shortened residual-heat removal chain available.	N-4, N-8, N-20	done	
KBR/ PWR	8	A systematic review of the robustness of emergency measures with consideration of external hazards has been carried out as part of a robustness analysis. With the existing and the new emergency measures it is possible to maintain/re-establish the vital functions even in the case of beyond-design-basis events.	N-5, N-13, N-20, N-18	done	
KBR/ PWR	9	Review and optimisation if necessary of the requirements for the containment venting system with consideration of station blackout conditions, adverse radiological conditions and the effectiveness following natural external design impacts. Suggestions were added to the Severe Accident Management Guidelines (SAMG) (see also KBR 29) and an already existing emergency measure was supplemented.	N-6, N-21, N-25	done	
KBR/ PWR	10	Creation of a permanently installed injection path into the spent fuel pool that is accessible from outside the containment. This injection path exists.	N-8, N-22	done	
KBR/ PWR	11	Preparation of comprehensive analyses and development of emergency measures regarding the loss of spent fuel pool cooling during beyond-design-basis accidents. Analyses comprise e.g. structural analyses of the spent fuel pool at increased temperatures, pressure build-up in the containment, radiology and heat-up and grace periods as well as the derivation of corresponding emergency measures (i.a. KBR/10).	N-8, N-22	done	
KBR/ PWR	12	Examination of the need to be able to initiate additional accident management measures from the remote shutdown and control station, too.	N-9	done	
KBR/ PWR	13	Provision of suitable means of communication to increase the robustness of the communication between crisis team, control room, remote shutdown and control station, and the supervisory and disaster control au-	N-10	done	

Plant/ type	No.	Activity/measure	Related rec-ommenda-tion	Status	Finalisation
		thorities. Equipment with satellite telephones has been done.			
KBR/ PWR	14	Review and improvement of the accessibility of the plant grounds and the plant itself after an earthquake and flooding. Accessibility is ensured by the existing and new measures.	N-11	done	
KBR/ PWR	15	Assessment of the CCF potential for the loss of the cir-culating water return structures and derivation of measures if necessary. The existing measures ensure sufficient precaution against CCFs.	N-12	done	
KBR/ PWR	16	Review of the safety clearances of safety-relevant build-ings. The existing safety clearances of the buildings re-main sufficient.	N-13	done	
KBR/ PWR	17	Installation of seismic instrumentation.	N-14	done	
KBR/ PWR	18	A systematic review of the robustness of the plant in the event of a beyond-design earthquake and flood (objec-tive: guarantee of vital functions) has been carried out as part of a robustness analysis. With the existing and the new emergency measures it is possible to main-tain/re-establish the vital functions even in the case of beyond-design-basis events.	N-14, N-15	done	
KBR/ PWR	19	Review and improvement of flood protection. The de-sign against flooding was re-viewed. Sufficient protec-tion is ensured by the measures that have been imple-mented.	N-15	done	
KBR/ PWR	20	A systematic review of the robustness of the plant in the event of a beyond-design flooding of the annulus (ob-jective: guarantee of vital functions) has been carried out as part of a robustness analysis. With the existing and the new emergency measures it is possible to maintain/re-establish the vital functions even in the case of beyond-design-basis events.	N-16	done	
KBR/ PWR	21	Review of the robustness of the plant regarding load crash events. For this purpose, an assessment of the existing precautionary measures and the robustness of the plant in connection with postulated load crash events was carried out. No further measures were de-rived.	N-17	done	
KBR/ PWR	22	Examination of the flooding-safe storage of safety-relevant equipment. Flooding-safe storage is ensured.	N-18	done	
KBR/ PWR	23	Review of the availability of the remote shutdown and control station. The remote shutdown and control sta-tion meets the requirements.	N-18	done	
KBR/ PWR	24	Review and optimisation if necessary of the robustness of the emergency measure “secondary steam generator bleed and feed”. The review of the optimisation options was concluded and a concept was prepared. Its imple-mentation has been concluded (in combination with KBR/3 and KBR/7).	N-18	done	
KBR/ PWR	25	Storage or stockage of equipment for pumping over or transporting secured fuel from depots. A concept was prepared. The implementation of the measures has been concluded (see KBR/7).	N-19	done	

Plant/ type	No.	Activity/measure	Related rec-ommenda-tion	Status	Finalisation
KBR/ PWR	26	Storage or stockage of fuels and lubricants. Sufficient fuels and lubricants are available at the plant, these are also available during flooding or earthquakes.	N-19	done	
KBR/ PWR	27	Measures and procedures to prolong the operating times of emergency diesel generators, using secured fuel stocks. A concept was prepared. The implementa-tion of the measures has been concluded.	N-19	done	
KBR/ PWR	28	Integrity verifications were prepared for the structures of the spent fuel pool for higher temperatures. No measures were derived.	N-22	done	
KBR/ PWR	29	Development and preparation of Severe Accident Man-agement Guidelines (SAMG), as well as introduction and instruction at the plant. Development, plant-specific adaptation and instruction completed.	N-23	done	
KBR/ PWR	30	Review of the robustness of vital safety functions in terms of the RSK Statement “Assessment of the cover-age of extreme weather conditions by the existing de-sign” with regard to whether it is possible that additional measures may make a contribution to further risk pre-caution that is not merely slight. No further measures are intended.	N-24	done	
KBR/ PWR	31	Examination and assessment of possible hydrogen re-leases into rooms outside the containment. Suggestions were added to the Severe Accident Management Guidelines (SAMG) (see also KBR 29).	N-26	done	
KKE/ PWR	1	Obtaining and providing a mobile emergency power generator set. These are designed such that they can provide the necessary power supply for the mentioned tasks. The mobile emergency power generator sets are ready for operation. It is furthermore possible by the in-tentional shutdown of emergency power generator sets and consumers to ensure the AC power supply at the plant for more than 7 days, using the available secured fuel supplies.	N-1, N-2, N-19	done	
KKE/ PWR	2	A self-contained, independent auxiliary service water supply (multiple-cell cooler) is available within the plant grounds. Hence a failure of the auxiliary service water supply need not be postulated even in the case of de-sign natural hazards.	N-3	no activity/ measure necessary	
KKE/ PWR	3	The plant already has an independent, diverse auxiliary service water supply (see KKE/2). Analyses have shown that further installations could not make a contri-bution to further risk precaution that wold not merely be slight.	N-4	no activity/ measure necessary	
KKE/ PWR	4	A systematic review of the robustness of emergency measures with consideration of external hazards was carried out. As a result it can be stated that it is general-ly possible to avoid cliff edge effects with the existing emergency measures, even in highly unlikely, beyond-design-basis events. The review of the activity/measure by the supervisory authority has not yet been concluded.	N-5, N-6, N-9, N-13	done	

Plant/ type	No.	Activity/measure	Related recommendation	Status	Finalisation
KKE/ PWR	5	Introduction of an emergency measure for initiating accumulator injection in mid-loop operation. The measure has been implemented and the execution of the individual steps is described in the corresponding document. The review of the activity/measure by the supervisory authority has not yet been concluded.	N-5, N-13	done	
KKE/ PWR	6	Use of the GRS-developed QPRO code as a diagnostic and prediction aid for source term calculation. The code was obtained and tested.	N-6, N-18, N-23	done	
KKE/ PWR	7	Not relevant in connection with KKE.	N-7	no activity/ measure necessary	
KKE/ PWR	8	Creation of a permanently installed injection path into the spent fuel pool that is accessible from outside the containment. These injection options have been implemented. The associated operational documents have been prepared.	N-8, N-22	done	
KKE/ PWR	9	Further means of communication have been provided to increase the robustness of the communication between crisis team, control room, remote shutdown and control station, and the supervisory and disaster control authorities. This has included the equipment with satellite phones.	N-10	done	
KKE/ PWR	10	Detailed information on aids by which the access to buildings can be regained after external hazards are contained i.a. in the Final EU Stress Test Report. Here, accessibility following external hazards was also assessed.	N-11	done	
KKE/ PWR	11	A review of the ultimate heat sink regarding any blockages of the cooling water inlet, the reliability upon the onset of rare external hazards and the control of the loss of the ultimate heat sink has shown that due to the plant-specific presence of the multi-cell coolers, the ultimate heat sink is highly reliable. Any losses of the ultimate heat sink are controlled by the independent auxiliary service water supply.	N-12	no activity/ measure necessary	
KKE/ PWR	12	Robustness regarding a beyond-design-basis earthquake was reviewed as part of the robustness analysis. As a result it can be stated that no contribution to further risk precaution for the general public that would not be merely slight can be achieved by further adequate safety precautions beyond the comprehensive technical as well as administrative measures that have already been implemented. The review of the activity/measure by the supervisory authority has not yet been concluded.	N-14	done	
KKE/ PWR	13	Not relevant in connection with KKE as the site of the reactor plant is to be considered as absolutely flooding-free. The design flood lies clearly below the zero elevation of the reactor plant.	N-15	no activity/ measure necessary	

Plant/ type	No.	Activity/measure	Related recommendation	Status	Finalisation
KKE/ PWR	14	A review of the robustness and an assessment of the consequences in the event of a beyond-design flooding of the annulus including the cooling of the spent fuel pool has been carried out. Owing to the limited coolant inventory in the auxiliary service water system, the effects of a flooding of the annulus remain slight The review of the activity/measure by the supervisory authority has not yet been concluded.	N-16	done	
KKE/ PWR	15	The review of this point has shown that the mentioned scenarios are safely prevented due to the technical and administrative measures taken.	N-17	no activity/ measure necessary	
KKE/ PWR	16	A review of the availability of the remote shutdown and control station was carried out. Potential for optimisation was recognised and acted upon by the relocation of the remote shutdown and control station.	N-18	done	
KKE/ PWR	17	Storage or stockage of equipment for pumping over or transporting secured fuel from depots. Sufficient fuels and lubricants are available at the plant. The equipment is stored in a correspondingly secure location. The review of the activity/measure by the supervisory authority has not yet been concluded.	N-19	done	
KKE/ PWR	18	Obtaining a further fire engine, with the option of choosing separate locations for the two vehicles within the plant grounds, so that access to equipment and aids is ensured in different locations within the plant grounds on demand. The additional fire engine has in the meantime been obtained.	N-20	done	
KKE/ PWR	19	Venting is possible in most external design hazards and during a station blackout. The effectiveness of the installations for hydrogen reduction was demonstrated by the installation of the H_2 recombiners. The effectiveness of filtered venting in an earthquake was assessed in qualified inspections. The review of the activity/measure by the supervisory authority has not yet been concluded.	N-21	done	
KKE/ PWR	20	Development and preparation of Severe Accident Management Guidelines (SAMG), as well as introduction and instruction at the plant. For this purpose, the manual for mitigating emergency measures was introduced.	N-23	done	
KKE/ PWR	21	Review of the robustness of vital safety functions by means of the RSK Statement “Coverage of extreme weather conditions” with regard to whether it is possible that additional measures can make a contribution to further risk prevention that is not merely slight. The review of the activity/measure by the supervisory authority has not yet been concluded.	N-24	done	
KKE/ PWR	22	Successful performance of analyses that during filtered venting, no safety-relevant effects of hydrogen combustion are to be expected in the exhaust air system.	N-25	done	

Plant/ type	No.	Activity/measure	Related recommendation	Status	Finalisation
KKE/ PWR	23	Review and assessment of potential hydrogen release in rooms outside the containment. Appropriate measures were added to the Severe Accident Management Guidelines (SAMG).	N-26	done	
KKI-2/ PWR	1	Preparation of a comprehensive and integrated concept for postulated SBO. The concept was prepared and includes i.a. the measures KKI-2/2, KKI-2/3 and KKI-2/4.	N-1, N-2, N-19	done	
KKI-2/ PWR	2	Obtaining and providing a mobile emergency diesel generator for the supply of vital I&C installations, SG emergency feeding, and battery support. Design done and order placed, generator set has been delivered and installed.	N-1, N-19	done	
KKI-2/ PWR	3	Obtaining and providing a mobile emergency diesel generator in the long-term range to supply an emergency RHR chain.	N-2, N-19	done	
KKI-2/ PWR	4	Establishment of connections points for connecting mobile emergency diesel generators with protection against external hazards in the area of the emergency feedwater building and in the area of the 3rd grid connection, design and planning concluded, connecting points have been established.	N-2, N-19	done	
KKI-2/ PWR	5	Development of an emergency measures for injecting coolant into the component cooling system to cool the reactor pressure vessel and the spent fuel pool in case of a loss of the ultimate heat sink (emergency measures mobile shortened residual-heat removal chain developed).	N-3, N-4	done	
KKI-2/ PWR	6	Creation of a diverse source of cooling water (water intake from a source other than the river).	N-3, N-12	done	
KKI-2/ PWR	7	Obtaining and providing mobile pumps as well as other injection equipment. An electrical pump for steam generator injection was obtained, the injection equipment for the mobile shortened residual-heat removal chain was delivered completely.	N-4, N-8, N-20	done	
KKI-2/ PWR	8	A systematic review of the robustness of emergency measures with consideration of external hazards has been carried out as part of a robustness analysis. With the existing and the new emergency measures it is possible to maintain/re-establish the vital functions even in the case of beyond-design-basis events.	N-5, N-6, N-9, N-13	done	
KKI-2/ PWR	9	Review and optimisation if necessary of the requirements for the containment venting system with consideration of station blackout conditions, adverse radiological conditions and the effectiveness following external natural design hazards. Suggestions were added to the Severe Accident Management Guidelines (SAMG) (see also KKI-2 28).	N-6, N-21, N-25	done	
KKI-2/ PWR	10	Creation of a permanently installed injection path into the spent fuel pool that is accessible from outside the containment. This injection path now exists.	N-8, N-22	done	
KKI-2/ PWR	11	Preparation of comprehensive analyses and development of emergency measures regarding the loss of spent fuel pool cooling during beyond-design-basis accidents. The analyses comprise e.g. structural analyses	N-8, N-22	done	

Plant/ type	No.	Activity/measure	Related rec- ommenda- tion	Status	Finalisation
		of the spent fuel pool at increased temperatures, pressure build-up in the containment, radiology and heat-up and grace periods as well as the derivation of corresponding emergency measures (i.a. KKI-2/10).			
KKI-2/ PWR	12	Examination of the need to be able to initiate additional accident management measures from the remote shutdown and control station, too.	N-9	done	
KKI-2/ PWR	13	Provision of suitable means of communication to increase the robustness of the communication between crisis team, control room, remote shutdown and control station, and the supervisory and disaster control authorities. For this purpose, satellite phones have been obtained.	N-10	done	
KKI-2/ PWR	14	Review and improvement of the accessibility of the plant grounds and the plant itself after an earthquake and flooding. Accessibility is ensured by the existing measures.	N-11	done	
KKI-2/ PWR	15	An assessment of the CCF potential for the loss of the circulating water return structures was carried out. Sufficient precautions against CCFs are provided by the existing measures.	N-12	done	
KKI-2/ PWR	16	Review of the safety clearances of safety-relevant buildings. The existing safety clearances of the buildings continue to be sufficient.	N-13	done	
KKI-2/ PWR	17	A systematic review of the robustness of the plant in the event of a beyond-design-basis earthquake and flood (objective: guarantee of vital functions) was carried out as part of a robustness analysis. With the existing and the new emergency measures it is possible to maintain/re-establish the vital functions even in beyond-design-basis events. Conclusion of the review by the supervisory authority is expected shortly.	N-14, N-15	done	
KKI-2/ PWR	18	A review and improvement of flood protection has been carried out. To do so, a new expert opinion on flooding was prepared which confirmed the existing design values.	N-15	done	
KKI-2/ PWR	19	A systematic review of the robustness of the plant in the event of a beyond-design flooding of the annulus (objective: guarantee of vital functions) was carried out as part of a robustness analysis. With the existing and the new emergency measures it is possible to maintain/re-establish the vital functions even in beyond-design-basis events.	N-16	done	
KKI-2/ PWR	20	Review of the robustness of the plant regarding load crash events. For this purpose, an assessment of the existing precautionary measures and the robustness of the plant in connection with postulated load crash events was carried out. No further measures were derived.	N-17	done	
KKI-2/ PWR	21	Examination of the flooding-safe storage of safety-relevant equipment. Flooding-safe storage is ensured.	N-18	done	

Plant/ type	No.	Activity/measure	Related rec-ommenda-tion	Status	Finalisation
KKI-2/ PWR	22	A review of the availability of the remote shutdown and control station was carried out. A new remote shutdown and control station was established which meets the requirements.	N-18	done	
KKI-2/ PWR	23	Review of the robustness of the emergency measure “secondary bleed and feed”. The review of the optimisation possibilities has been concluded and a concept has been prepared and implemented (in combination with KKI-2/2 and KKI-2/7).	N-18	done	
KKI-2/ PWR	24	Storage or stockage of equipment for pumping over or transporting secured fuel from depots, equipment is available.	N-19	done	
KKI-2/ PWR	25	Storage or stockage of fuels and lubricants. Sufficient fuels and lubricants are available at the plant which are also available in the event of a flood or an earthquake.	N-19	done	
KKI-2/ PWR	26	Measures and procedures are planned to prolong the operating times of emergency diesel generators, using secured fuel stocks. A concept has been prepared and the measures have been implemented.	N-19	done	
KKI-2/ PWR	27	Integrity verifications have been prepared for the structures of the spent fuel pool for higher temperatures. No further measures are necessary.	N-22	done	
KKI-2/ PWR	28	Development and preparation of Severe Accident Management Guidelines (SAMG), as well as introduction and instruction at the plant. Development, preparation, plant-specific adaptation, introduction and instruction completed.	N-23	done	
KKI-2/ PWR	29	Review of the robustness of vital safety functions by means of the RSK Statement “Coverage of extreme weather conditions by the existing design” with regard to whether it is possible that additional measures can make a contribution to further risk prevention that is not merely slight. No further measures are intended.	N-24	done	
KKI-2/ PWR	30	Examination and assessment of possible hydrogen releases into rooms outside the containment. Suggestions were added to the Severe Accident Management Guidelines (SAMG) (see also KKI-2/28).	N-26	done	
KKP 2/ PWR	1	Assurance of DC power supply over a period of 10 h with the help of an on-site mobile diesel generator. Operability was demonstrated in the 2012 refuelling outage. Technical description and procedures are available. (BW[44] 1)	N-1	done	[45]

44 Numbers indicated refer to the serial number in the Action Plan of Baden-Wurttemberg (BW), as at 31 December 2015

45 All dates relating to the GKN I, GKN II, KKP 1 and KKP 2 nuclear power plants correspond to the Action Plan of Baden-Wurttemberg (BW), as at 31 December 2015

Plant/ type	No.	Activity/measure	Related rec-ommenda-tion	Status	Finalisation
KKP 2/ PWR	2	Obtaining and providing two mobile diesel generators at the site: Operability was demonstrated in the 2012 refu-elling outage. Technical description and procedures available. Studies of long-lasting loss of off-site power and resistance to external hazards have been submit-ted. The supervisory authority is in the act of checking whether further information is needed. (BW 2-3)	N-2, N-19	done	
KKP 2/ PWR	3	A statement on fuel cooling has been prepared. The primary heat sink is the Rhine, the diverse heat sink is a well. (BW 5-6)	N-3, N-12	done	
KKP 2/ PWR	4	A statement on fuel cooling has been prepared. An ad-ditional option of injecting into the component cooling system would not make a meaningful contribution due to the available diverse heat sink. The RSK was asked for a supplementary statement. (BW 7-8)	N-4, N-12	in progress	2016
KKP 2/ PWR	5	An assessment of reactor pressure vessel injection is available. The RSK was asked for a supplementary statement. (BW 4, 9)	N-5, N-20	in progress	2016
KKP 2/ PWR	6	Possibility of containment venting without electricity supply has been verified, additional studies into hydro-gen propagation have been carried out. Additional stud-ies into seismic resistance have been presented. In this context, the latest recommendations of the RSK of 15/04/2015 on hydrogen release have been dis-cussed (N-25, N-26). Additional information is required. (BW 17-18)	N-6, N-21, N-25, N-26	done in progress	 2016
KKP 2/ PWR	7	Measure for injecting into the spent-fuel pool and oper-ability demonstrated during the 2012 refuelling outage, technical description and procedures have been pre-pared. A concept for evaporation cooling has been pre-sented. (BW 11)	N-8, N-22	done	
KKP 2/ PWR	8	The emergency measures to be considered can be ini-tiated in case of a loss of the main control room either from the remote shutdown and control station or on site. The initiation criteria are discernible in the remote shut-down and control station. (BW 19)	N-9	done	
KKP 2/ PWR	9	Equal means of communication are installed and ready for operation. (BW 20)	N-10	done	
KKP 2/ PWR	10	No generation of debris in the case of a design basis earthquake. Additional safety margins for the case of beyond-design earthquakes exist. Equipment for clear-ing debris is provided in diverse locations. Emergency protection measures are ensured. (BW 21)	N-11	done	
KKP 2/ PWR	11	For the KKP II plant, no CCF potential for the loss of the circulating water return structures was identified. (BW 12)	N-12	done	
KKP 2/ PWR	12	The reassessment of the ultimate and the diverse heat sink has been concluded with positive result. (BW 30)	N-12	done	

Plant/ type	No.	Activity/measure	Related recommendation	Status	Finalisation
KKP 2/ PWR	13	An additional assessment of the safety margins of the auxiliary service water and ventilation systems under extreme weather conditions has been presented. Supplementary requirements due to the RSK Statement of 6 November 2013. A statement by the operator is available. The supervisory authority is in the act of checking whether further information is needed. (BW 26)	N-13, N-24	done	
KKP 2/ PWR	14	Specification of boundary conditions for ensuring the feasibility of emergency measures. For selected emergency procedures with special relevance (primary bleed, secondary bleed, filtered venting, external fuel pool injection and creation of a mobile emergency power supply), there was a positive assessment of the operability in the event of external design impacts.	N-13, N-18	done	
		A robustness analysis has been carried out and presented. Technical discussion on the robustness analysis necessary. (BW 13-15)		in progress	2016
KKP 2/ PWR	15	Accessibility and safety under flooding conditions are ensured. (BW 23-25)	N-15	done	
KKP 2/ PWR	16	Assurance of residual-heat removal through installation of a nozzle for steam generator feeding with mobile pump. (BW 4)	N-20	done	
KKP 2/ PWR	17	Measures for spent fuel pool injection have been installed and their operability demonstrated during the 2012 outage. A technical description and procedure have been prepared. The operability of evaporation cooling has been demonstrated. (BW 10)	N-22	done	
KKP 2/ PWR	18	Severe Accident Management Guidelines (SAMG) for power operation and for low-power and shutdown states have been prepared and implemented. (BW 16)	N-23	done	
KRB B+C/ BWR	1	Mobile diesel generators have been obtained. These are dimensioned such that they can provide the necessary power for the supply of consumers of the battery system, ventilation and lighting distribution of a safety subsystem. Preparation of the corresponding chapters of the emergency manual and the determination of the scope of in-service inspection has been concluded.	N-1, N-2, N-19	done	
KRB B+C/ BWR	2	Systematic review of the robustness of emergency measures with consideration of external hazards. A corresponding report has been prepared.	N-5, N-6, N-9, N-13	done	

Plant/ type	No.	Activity/measure	Related recommendation	Status	Finalisation
KRB B+C/ BWR	3	Use of the GRS-developed QPRO code as a diagnostic and prediction aid for source term calculation. The code is being adapted on the basis of results of the plant-specific Level 2 PSA. A scenario for the validation of QPRO was developed and the code was fully introduced in an exercise in June 2014.	N-6, N-18, N-23	done	
KRB B+C/ BWR	4	Passive autocatalytic H_2 recombiners are installed in the area of the spent fuel pool as a safety-related measure. This has been done successfully in both units.	N-7	done	
KRB B+C/ BWR	5	Introduction of new/optimisation of existing emergency measures: - Early opening of motorised pressure relief valves. - Increase of the possible pressure of reactor pressure vessel injection via mobile pumps. - Additional option of using fire engines as mobile pumps for reactor pressure vessel injection. - Early switch-off of individual diesel generators to conserve fuel supplies. - Quicker execution of the emergency measure for injecting into the spent fuel pool.	N-8, N-18, N-19	done	
KRB B+C/ BWR	6	Creation of a permanently installed injection path into the spent fuel pool that is accessible from outside the reactor building. Additional to the already existing emergency measure (connection of a fire extinguishing hose to the fire extinguishing line of the spent fuel pools), an installation is permanently installed as an emergency measure for spent fuel cooling so the there is no need in case of a challenge to enter any rooms that are at risk.	N-8, N-22	done	
KRB B+C/ BWR	7	Obtaining further means of communication to increase the robustness of the communication between crisis team, control room, remote shutdown and control station, and the supervisory and disaster control authorities. The control room and, amongst others, the emergency organisation, have been equipped with satellite phones. Hence communication in an emergency is ensured.	N-10	done	
KRB B+C/ BWR	8	Obtaining boats to improve accessibility of the plant grounds in a flood. Three boats for conveyance of passengers have been obtained.	N-13, N-15	done	
KRB B+C/ BWR	9	Review and improvement of flood protection. Recent studies have shown that the site will not be flooded in a design flood (discharge amount from the postulated underlying the construction). The safety margins until the design flooding levels are reached are greater than originally assumed. Notwithstanding, provisions have been made for the temporary installation of mobile sheet pile walls to improve the accessibility of those access doors for which structural flooding protection (staircases) has been realised within the buildings.	N-15	done	

Plant/ type	No.	Activity/measure	Related recommendation	Status	Finalisation
KRB B+C/ BWR	10	A review of the availability of the remote shutdown and control station was carried out. Afterwards, a new remote shutdown station was set up, which represents an improvement as regards availability. Its equipment was completed.	N-18	done	
KRB B+C/ BWR	11	Storage or stockage of equipment for pumping over or transporting secured fuel from depots. A central fuel installation was established. In a challenge, the fuel will be transported to the HydroSub pumps or the mobile emergency power generator units by suitable vehicles. Conclusion of the review by the supervisory authority is expected shortly.	N-19	done	
KRB B+C/ BWR	12	Integrity demonstration for spent fuel pools at 100 °C and assessment of the heat transport. Compliance with the protection goals “Spent fuel pool cooling through evaporation and make-up feeding of water in beyond-design-basis events” has been demonstrated.	N-22	done	
KRB B+C/ BWR	13	Development and preparation of Severe Accident Management Guidelines (SAMG), as well as introduction and instruction at the plant. The Severe Accident Management Guidelines (SAMG) were prepared in the form of a manual for mitigating accident management measures (HMN) and adopted into the operating rules of KRB II. They were successfully validated in an emergency exercise in June 2014.	N-23	done	
KRB B+C/ BWR	14	Review of the robustness of vital safety functions by means of the RSK Statement with regard to whether it is possible that additional measures can make a contribution to further risk prevention that is not merely slight. This review was carried out.	N-24	done	
KRB B+C/ BWR	15	Examination and assessment of potential hydrogen releases into rooms outside the containment. Suggestions were added to the Severe Accident Management Guidelines (SAMG).	N-26	done	
KWG/ PWR	1	Preparation of a comprehensive and integrated concept regarding postulated station blackout scenarios. The concept was prepared and comprises i.a. the measure KWG/2 and the optimisation of KWG/3 and KWG/4.	N-1, N-2, N-19	done	
KWG/ PWR	2	Obtaining and providing a mobile emergency diesel generator for the supply of vital I&C installations, SG emergency feeding, and battery support (implementation of a further-reaching concept throughout the business group completed).	N-1, N-19	done	
KWG/ PWR	3	Obtaining and providing a mobile emergency diesel generator in the long-term range to supply an emergency RHR chain (implementation of a further-reaching business-group-wide concept completed).	N-2, N-19	done	

Plant/ type	No.	Activity/measure	Related recommendation	Status	Finalisation
KWG/ PWR	4	Establishment of connections points for connecting mobile emergency diesel generators with protection against external hazards in the area of the emergency feedwater building. Design, planning and realisation of injection points have been concluded.	N-2, N-19	done	
KWG/ PWR	5	Development of an emergency measures for injecting coolant into the component cooling system to cool the reactor pressure vessel and the spent fuel pool in case of a loss of the ultimate heat sink (emergency measure shortened mobile residual-heat removal chain developed). The review of the activity/measure by the supervisory authority has not yet been concluded.	N-3, N-4	done	
KWG/ PWR	6	Creation of a diverse source of cooling water (a diverse water intake point from the river is used).	N-3, N-12	done	
KWG/ PWR	7	Obtaining and providing mobile pumps as well as other injection equipment. Equipment for pumping over fuel, electrical pump for steam generator feeding available, injection equipment for mobile shortened residual-heat removal chain fully delivered.	N-4, N-8, N-20	done	
KWG/ PWR	8	A systematic review of the robustness of emergency measures with consideration of external hazards has been carried out as part of a robustness analysis. With the existing and the new emergency measures it is possible to maintain/re-establish the vital functions even in the case of beyond-design-basis events.	N-5, N-6, N-9, N-13	done	
KWG/ PWR	9	Review and optimisation if necessary of the requirements for the containment venting system with consideration of station blackout conditions, adverse radiological conditions and the effectiveness following natural external design impacts. Suggestions were added to the Severe Accident Management Guidelines (SAMG) (see also KWG 28).	N-6, N-21, N-25	done	
KWG/ PWR	10	Creation of a permanently installed injection path into the spent fuel pool that is accessible from outside the containment.	N-8, N-22	done	
KWG/ PWR	11	Preparation of comprehensive analyses and development of emergency measures regarding the loss of spent fuel pool cooling during beyond-design-basis accidents. Analyses comprise e.g. structural analyses of the spent fuel pool at increased temperatures, pressure build-up in the containment, radiology and heat-up and grace periods as well as the derivation of corresponding emergency measures (i.a. KWG/10). The review of the activity/measure by the supervisory authority has not yet been concluded.	N-8, N-22	done	
KWG/ PWR	12	Examination of the need to be able to initiate additional accident management measures from the remote shutdown and control station, too.	N-9	done	

Plant/ type	No.	Activity/measure	Related recommendation	Status	Finalisation
KWG/ PWR	13	Provision of suitable means of communication to increase the robustness of the communication between crisis team, control room, remote shutdown and control station, and the supervisory and disaster control authorities. Equipment with satellite telephones has been done.	N-10	done	
KWG/ PWR	14	Review and improvement of the accessibility of the plant grounds and the plant itself after an earthquake and flooding. Accessibility is ensured by the existing and new measures.	N-11	done	
KWG/ PWR	15	Assessment of the CCF potential for the loss of the circulating water return structures and derivation of measures if necessary. The existing measures ensure sufficient precaution against CCFs.	N-12	done	
KWG/ PWR	16	Review of the safety clearances of safety-relevant buildings. The existing safety clearances of the buildings remain sufficient.	N-13	done	
KWG/ PWR	17	A systematic review of the robustness of the plant in the event of a beyond-design earthquake and flood (objective: guarantee of vital functions) has been carried out as part of a robustness analysis. With the existing and the new emergency measures it is possible to maintain/re-establish the vital functions even in the case of beyond-design-basis events.	N-14, N-15	done	
KWG/ PWR	18	Review and improvement of flood protection. The design against flooding was reviewed. Sufficient protection is ensured by the measures that have been implemented.	N-15	done	
KWG/ PWR	19	A systematic review of the robustness of the plant in the event of a beyond-design flooding of the annulus (objective: guarantee of vital functions) has been carried out as part of a robustness analysis. With the existing and the new emergency measures it is possible to maintain/re-establish the vital functions even in the case of beyond-design-basis events.	N-16	done	
KWG/ PWR	20	Review of the robustness of the plant regarding load crash events. For this purpose, an assessment of the existing precautionary measures and the robustness of the plant in connection with postulated load crash events was carried out. No further measures were derived.	N-17	done	
KWG/ PWR	21	Examination of the flooding-safe storage of safety-relevant equipment. Flooding-safe storage is ensured.	N-18	done	
KWG/ PWR	22	Review of the availability of the remote shutdown and control station. The remote shutdown and control station meets the requirements.	N-18	done	
KWG/ PWR	23	Review and optimisation if necessary of the robustness of the emergency measure “secondary bleed and feed”. The review of the optimisation options was concluded and a concept was prepared. Its implementation has been concluded (in combination with KWG/3 and KWG/7).	N-18	done	
KWG/ PWR	24	Storage or stockage of equipment for pumping over or transporting secured fuel from depots. Corresponding equipment is available.	N-19	done	

Plant/ type	No.	Activity/measure	Related recommendation	Status	Finalisation
KWG/ PWR	25	Storage or stockage of fuels and lubricants. Sufficient fuels and lubricants are available at the plant, these are also available during flooding or in earthquakes.	N-19	done	
KWG/ PWR	26	Measures and procedures to prolong the operating times of emergency diesel generators, using secured fuel stocks. A concept has been prepared, the measures have been implemented.	N-19	done	
KWG/ PWR	27	Integrity verifications for the structures of the spent fuel pool for higher temperatures have been provided. No measures are required. The review of the activity/measure by the supervisory authority has not yet been concluded.	N-22	done	
KWG/ PWR	28	Development and preparation of Severe Accident Management Guidelines (SAMG), as well as introduction and instruction at the plant. Development, preparation, plant-specific adaptation, introduction and instruction completed.	N-23	done	
KWG/ PWR	29	Review of the robustness of vital safety functions by means of the RSK Statement “Coverage of extreme weather conditions by the existing design” with regard to whether it is possible that additional measures can make a contribution to further risk prevention that is not merely slight. No further measures are intended.	N-24	done	
KWG/ PWR	30	Review and assessment of potential hydrogen release in rooms outside the containment. Suggestions were added to the Severe Accident Management Guidelines (SAMG) (see also KWG/28).	N-26	done	

Plants in post-operation

Plant/ type	No.	Activity/measure	Related recommen-dation	Status	Planned finalisation
GKN I/ PWR	1	Statement on the maintenance of the electricity supply on the basis of a safety analysis. An additional diesel generator has been obtained. The supervisory authority is in the act of checking whether further information is needed. (BW[46] 1-3)	N- 1, N- 2, N-19	done	[47]
GKN I/ PWR	2	A statement on fuel cooling on the basis of a safety analysis has been presented. A diverse heat sink (well) exists. (BW 5-6)	N- 3, N-12	done	
GKN I/ PWR	3	A statement on additional component cooling system injection on the basis of a safety analysis has been presented. In the event of multiple failures, there is an alternative technical option for heat removal from the spent fuel pool. (BW 7-8)	N- 4, N-12	done	
GKN I/ PWR	4	A statement on more stringent requirements for filtered containment venting on the basis of a safety analysis has been presented. Due to the plant state, no further measures are required. In this context, the new recommendations of the RSK of 15 April 2015 on hydrogen release are also dealt with (N-25, N-26). Due to the plant state, no further measures are required. (BW 17-18)	N- 6, N-21, N-25, N-26	done	
GKN I/ PWR	5	Measure for injecting into the spent-fuel pool and operability was established. Function testing has been done. (BW 11)	N-8, N-22	done	
GKN I/ PWR	6	In case of a loss of the main control room, the emergency measure “injection into the spent fool” to be considered with the present plant state can either be initiated from the remote shutdown and control station or directly on the spot. The initiation criteria can be seen at the remote shutdown and control station. (BW 19)	N-9	done	
GKN I/ PWR	7	Equal means of communication have been installed and are ready for operation. (BW 20)	N-10	done	
GKN I/ PWR	8	No debris formation in case of design earthquake. Additional safety margins in case of beyond-design- basis earthquakes are available. Removal equipment and devices are accommodated diversely. Emergency preparedness is ensured. (BW 21)	N-11	done	
GKN I/ PWR	9	For the GKN I plant, no CCF potential for the loss of the circulating water return structures was identified. (BW 12)	N-12	done	
GKN I/ PWR	10	Statement on the reliability of the ultimate heat sink on the basis of a safety analysis. (BW 30)	N-12	done	

46 Numbers indicated refer to the serial number in the Action Plan of Baden-Wurttemberg (BW), as at 31 December 2015

47 All dates relating to the GKN I, GKN II, KKP 1 and KKP 2 nuclear power plants correspond to the Action Plan of Baden-Wurttemberg (BW), as at 31 December 2015

Plant/ type	No.	Activity/measure	Related recommen-dation	Status	Planned finalisation
GKN I/ PWR	11	Additional estimates of the safety margins of auxiliary service water and ventilation under extreme weather conditions. Additional requirements due to the RSK Statement of 6 November 2013. A statement by the operator is available. The supervisory authority is in the act of checking whether further information is needed. (BW 26)	N-13, N-24	done	
GKN I/ PWR	12	A robustness analysis was performed and presented. Technical discussion on the robustness analysis necessary. (BW 13-15)	N-13, N-18	done in progress	2016
GKN I/ PWR	13	Accessibility and safety during flooding are ensured. (BW 23-25)	N-15	done	
GKN I/ PWR	14	An additional option of injecting into the reactor coolant system is not relevant for GKN I as all fuel assemblies are in the spent fuel pool. (BW 4)	N-20	done	
GKN I/ PWR	15	Possibility of injection has been established. A statement on evaporation cooling on the basis of a safety analysis has been provided. (BW 10)	N-22	done	
GKN I/ PWR	16	Severe Accident Management Guidelines (SAMG) have already been introduced for power operation prior to 2012. GKN I has developed manual actions for low-power and shutdown operation that can also be used as recommended actions within the framework of Severe Accident Management (SAM). (BW 16)	N-23	done	
KKB/ BWR	1	Analyses and statements within the framework of the optimisation of post-operation have been carried out. This concept comprises the safety-related installations and measures necessary for post-operation, taking the aspects resulting from the national Action Plan into account.	N-1 to N-23	done	
KKB/ BWR	2	Analysis of the accident behaviour of fuel assemblies in the spent fuel pool. Considering the decay heat output of 120 kW, the heat sinks through evaporation, heat transfer via the pool walls, heat transfer to the room air and radiation exchange with the ceiling of the building, grace periods of more than 40 days ensue. Within this time, situation-dependent manual actions can be taken to resume heat removal or coolant make-up. Hence the recommendation yields no need for any action regarding the KKB plant.	N-7	done	

Plant/ type	No.	Activity/measure	Related recommen-dation	Status	Planned finalisation
KKB/ BWR	3	Different statements on the recommendations regarding station blackout, functions of the remote shutdown and control station, influence of external hazards on emergency measures, etc. Parallel to the preparation of the post-operation concept, the issues referred to were addressed in corresponding statements: Due to the existing long grace periods, there is sufficient time available for the execution of necessary safety-related measures. With the its independent emergency system (UNS), the KKB plant disposes of a system that is able to ensure sufficient injection and heat removal in a manner that is diverse from the emergency core cooling and residual-heat removal systems. Against this background there is no need for action for the plant.	N-1 to N-4, N-6 to N-11	done	
KKB/ BWR	4	Statement on the RSK recommendation regarding a reinforcement of the ultimate heat sink. With the its UNS system, the KKB plant disposes of a system that removes the residual heat via air coolers in a manner that is diverse from the ultimate heat sink and which hence ensures sufficient residual-heat removal. This system is designed to withstand external hazards. Against this background, there is no resulting need for action for the plant.	N-12	done	
KKB/ BWR	5	Statement on the RSK recommendation regarding the assessment of robustness. Against the background of the current state of the plant in post-operation, the existing design safety margins and the low seismic activity of the site, the plant shows a correspondingly high robustness against external hazards. An increase of the intensity by one level to I=7, which correlates approximately with a PGA value of 0.1 g, does not result in any damage to structures and installations that would impair their functions. In our opinion, it is furthermore possible if necessary to carry out emergency and repair measures to ensure fuel cooling within the existing grace periods until acceptance criteria are transgressed. Hence these considerations do not lead to any conclusions regarding an enhancement of the degree of robustness.	N-13 to N-23	done	
KKB/ BWR	6	Study of external hazards, optimisation of fuel assembly storage. The development of the post-operation concept also included the optimisation of fuel assembly storage. Additional considerations in connection with the measures for flooding protection led to supplementary additions to the emergency manual.	N-14 to N-18	done	
KKB/ BWR	7	No longer relevant for the present plant state. Hydrogen releases due to radiolysis are no longer to be expected in the current post-operational phase even under accident conditions.	N-25, N-26	done	

Plant/ type	No.	Activity/measure	Related recommen-dation	Status	Planned finalisation
KKG/ PWR	1	Preparation of a comprehensive and integrated concept for postulated station blackout scenarios. The concept was prepared and includes i.a. the measures KKG/2, KKG/3 and KKG/4 (see below).	N-1, N-2, N-19	done	
KKG/ PWR	2	Establishment of connections points for connecting mobile emergency diesel generators with protection against external hazards in the area of the emergency feedwater building. The design, planning and realisation of the feed points was concluded.	N-1, N-2, N-19	done	
KKG/ PWR	3	Obtaining and providing a mobile emergency diesel generator for the supply of vital I&C installations, SG emergency feeding, and battery support. Design done and order placed, generator set has been delivered and installed.	N-1, N-19	done	
KKG/ PWR	4	Obtaining and providing a mobile emergency diesel generator in the long-term range to supply an emergency RHR chain. Design done and order placed, generator set has been delivered and installed.	N-2, N-19	done	
KKG/ PWR	5	Development of an emergency measures for injecting coolant into the component cooling system to cool the reactor pressure vessel and the spent fuel pool in case of a loss of the ultimate heat sink (emergency measure “mobile shortened residual-heat removal chain” developed).	N-3, N-4	done	
KKG/ PWR	6	Creation of a diverse source of cooling water (water intake from a source other than the river)	N-3, N-12	done	
KKG/ PWR	7	Obtaining and providing mobile pumps as well as other injection equipment. An electrical pump for steam generator injection was obtained, the injection equipment for the mobile shortened residual-heat removal chain was delivered completely.	N-4, N-8, N-20	done	
KKG/ PWR	8	A systematic review of the robustness of emergency measures with consideration of external hazards was carried out as part of a robustness analysis. With the existing and the new emergency measures it is possible to maintain/re-establish the vital functions even in beyond-design-basis events.	N-5, N-6, N-9, N-13, N-20	done	
KKG/ PWR	9	Review and optimisation if necessary of the requirements for the containment venting system with consideration of station blackout conditions, adverse radiological conditions and the effectiveness following external natural design hazards.	N-6, N-21	done	
KKG/ PWR	10	A permanently installed injection path into the spent fuel pool that is accessible from outside the containment has been created.	N-8, N-22	done	
KKG/ PWR	11	Preparation of comprehensive analyses and development of emergency measures regarding the loss of spent fuel pool cooling during beyond-design-basis accidents. The analyses comprise e.g. structural analyses of the spent fuel pool at increased temperatures, pressure build-up in the containment, radiology and heat-up and grace periods as well as the derivation of corresponding emergency measures (i.a. KKG/10).	N-8, N-22	done	
KKG/ PWR	12	Examination of the need to be able to initiate additional accident management measures from the remote shutdown and control station, too.	N-9	done	

Plant/ type	No.	Activity/measure	Related recommen-dation	Status	Planned finalisation
KKG/ PWR	13	Provision of suitable means of communication to increase the robustness of the communication between crisis team, control room, remote shutdown and control station, and the supervi-sory and disaster control authorities. Satellite phones have been obtained for this purpose.	N-10	done	
KKG/ PWR	14	Review and improvement of the accessibility of the plant grounds and the plant itself after an earthquake and flooding. Accessibility is ensured by the existing and the new measures.	N-11	done	
KKG/ PWR	15	Assessment of the CCF potential for the loss of the circulating water return structures. The existing measures provide suffi-cient precautions against CCFs.	N-12	done	
KKG/ PWR	16	Review of the safety clearances of safety-relevant buildings. The existing safety clearances continue to be sufficient.	N-13	done	
KKG/ PWR	17	A systematic review of the robustness of the plant in the event of a beyond-design earthquake and flood (objective: guarantee of vital functions) was carried out as part of a ro-bustness analysis. With the existing and the new emergency measures it is possible to maintain/re-establish the vital func-tions even in beyond-design-basis events. Conclusion of the review by the supervisory authority is ex-pected shortly.	N-14, N-15	done	
KKG/ PWR	18	The flood protection design was reviewed. The measures that have been implemented ensure sufficient protection.	N-15	done	
KKG/ PWR	19	A systematic review of the robustness of the plant in the event of a beyond-design flooding of the annulus (objective: guarantee of vital functions) was carried out as part of a ro-bustness analysis. With the existing and the new emergency measures it is possible to maintain/re-establish the vital func-tions even in beyond-design-basis events.	N-16	done	
KKG/ PWR	20	Review of the robustness of the plant regarding load crash events. For this purpose, an assessment of the existing pre-cautionary measures and the robustness of the plant in con-nection with postulated load crash events was carried out. No further measures were derived.	N-17	done	
KKG/ PWR	21	Examination of the flooding-safe storage of safety-relevant equipment. Flooding-safe storage is ensured.	N-18	done	
KKG/ PWR	22	Review of the availability of the remote shutdown and control station. The remote shutdown and control station meets the requirements.	N-18	done	
KKG/ PWR	23	Review and optimisation if necessary of the robustness of the emergency measure “secondary bleed and feed”. The review of the optimisation possibilities has been concluded and a concept has been prepared and implemented (in combination with KKG/3 and KKG/7).	N-18	done	
KKG/ PWR	24	Storage or stockage of equipment for pumping over or trans-porting secured fuel from depots. No other measures than the ones already implemented are necessary.	N-19	done	
KKG/ PWR	25	Storage or stockage of fuels and lubricants. Sufficient fuels and lubricants are available at the plant which are also avail-able in the event of a flood or an earthquake.	N-19	done	

Plant/ type	No.	Activity/measure	Related recommen-dation	Status	Planned finalisation
KKG/ PWR	26	Measures and procedures to prolong the operating times of emergency diesel generators, using secured fuel stocks. A concept has been prepared and the measures have been implemented completely.	N-19	done	
KKG/ PWR	27	Integrity verifications for the structures of the spent fuel pool for higher temperatures have been prepared. There are no further measures necessary.	N-22	done	
KKG/ PWR	28	Development and preparation of Severe Accident Management Guidelines (SAMG), as well as introduction and instruction at the plant. Development, preparation, plant-specific adaptation, introduction and instruction completed.	N-23	done	
KKG/ DWR	29	Bewertung der Robustheit vitaler Sicherheitsfunktionen anhand der RSK-Stellungnahme “Einschätzung der Abdeckung extremer Wetterbedingungen durch die bestehende Auslegung” dahingehend, ob durch zusätzliche Maßnahmen ein nicht nur geringfügiger Beitrag zur weiteren Vorsorge gegen Risiken erbracht werden kann. Es sind keine zusätzlichen Maßnahmen vorgesehen.	N-24	erledigt	
KKG/ PWR	30	No longer relevant for the present plant state.	N- 25, N-26	done	
KKI-1/ BWR	1	Assessment of the robustness of the emergency measures regarding heat removal from the spent fuel pool in the event of a station blackout, implementation of emergency measures.	N-1, N-2, N-13, N-22	done	
KKI-1/ BWR	2	Creation of a diverse source of cooling water.	N-3, N-12	done	
KKI-1/ BWR	3	Assessment of the consequences of a loss of the ultimate primary heat sink regarding the cooling of the spent fuel pool.	N-3, N-4, N-12, N-22	done	
KKI-1/ BWR	4	Obtaining and providing mobile pumps and other injection equipment.	N-4, N-20	done	
KKI-1/ BWR	5	Optimisation and supplementation of emergency measures regarding the feeding/overfeeding of the spent fuel pool.	N-8, N-22	done	
KKI-1/ BWR	6	Assessment of the robustness of the emergency measures regarding heat removal from the spent fuel pool.	N-9, N-13, N-22	done	
KKI-1/ BWR	7	Provision of suitable means of communication to increase the robustness of the communication between crisis team, control room, remote shutdown and control station, and the supervisory and disaster control authorities.	N-10	done	
KKI-1/ BWR	8	Review and improvement of the accessibility of the plant grounds and the plant itself after an earthquake and flooding.	N-11	done	
KKI-1/ BWR	9	Assessment of the CCF potential for the loss of the circulating water return structures and derivation of measures if necessary.	N-12	done	
KKI-1/ BWR	10	Review of the safety clearances of safety-relevant buildings.	N-13	done	
KKI-1/ BWR	11	Review of flood protection.	N-15	done	
KKI-1/ BWR	12	Examination of the flooding-safe storage of safety-relevant equipment.	N-18	done	

Plant/ type	No.	Activity/measure	Related recommen-dation	Status	Planned finalisation
KKI-1/ BWR	13	Review of the availability of the remote shutdown and control station.	N-18	done	
KKI-1/ BWR	14	Storage or stockage of equipment for pumping over or transporting secured fuel from depots.	N-19	done	
KKI-1/ BWR	15	Storage or stockage of fuels and lubricants.	N-19	done	
KKI-1/ BWR	16	Development of procedures and measures for the prevention and mitigation of beyond-design-basis accidents in the area of the spent fuel pool.	N-22	done	
KKI-1/ BWR	17	Evaluation of whether the RSK Statement “Assessment of the coverage of extreme weather conditions by the existing design” is relevant for the current plant state. Result: The recommendation is not relevant for the current plant state with little decay heat in the spent fuel pool.	N-24	done	
KKI-1/ BWR	18	No longer relevant for the present plant state.	N- 25, N-26	done	
KKK/ BWR	1	Different statements on recommendations regarding station blackout, cooling water supply, filtered venting, H_2 production, emergency measures, etc. Considering the decay heat output of less than 300 kW, grace periods of more than 6 days ensue under conservative boundary conditions until an accident-induced temperature of 60 °C is reached. Within this time-span, situation-dependent manual actions can be taken to resume heat removal or coolant make-up.	N-1, N-3, N-4, N-6, N-7, N-8, N-10, N-11	done	
KKK/ BWR	2	Statement on the recommendations regarding station blackout, functions of the remote shutdown and control station, influence of external hazards on emergency measures. Considering the decay heat output of less than 300 kW, grace periods of more than 6 days ensue under conservative boundary conditions until an accident-induced temperature of 60 °C is reached. Within this time-span, situation-dependent manual actions can be taken to resume heat removal or coolant make-up. For the emergency power generator units, the emergency measure “repeat of diesel start-up” was added for the remote shutdown and control station (control unit for operation and monitoring in case of specific external hazards). Accessibility of the plant buildings and the execution of emergency measures are assured at any time by the existing grace periods.	N-2, N-9, N-18	done	
KKK/ BWR	3	Analysis of the accident behaviour of fuel assemblies in the spent fuel pool. Considering the long grace periods (approx. two weeks for a heat-up of the fuel pool water from 25 to 80 °C or approx. 3 months for the evaporation of the fuel pool water down to the upper edge of the fuel assemblies), it is not necessary to employ passive installations for avoiding hydrogen accumulations in the reactor building above the spent fuel pool. The long grace periods allow the timely implementation of measures for the re-establishment of the necessary heat removal.	N- 7	done	

Plant/ type	No.	Activity/measure	Related recommen-dation	Status	Planned finalisation
KKK/ BWR	4	Development of measures for the additional injection into the spent fuel pool. The installations are largely permanently installed, and the rooms that need to be entered in a challenge are physically separate from the spent fuel pool. The emergency manual was supplemented by a further measure for injecting into the spent fuel pool. The accessibility of the plant buildings and the execution of emergency measures are ensured at any time due to the existing grace periods.	N- 8, N-18	done	
KKK/ BWR	5	Statement on the RSK recommendation regarding a reinforcement of the ultimate primary heat sink. Considering the decay heat output of less than 300 kW, grace periods of more than 6 days ensue under conservative boundary conditions until an accident-induced temperature of 60 °C is reached. Within this time-span, situation-dependent manual actions can be taken to resume heat removal or coolant make-up.	N-12	done	
KKK/ BWR	6	Statement on the RSK recommendation regarding the assessment of robustness. The KKK plant has been designed to withstand an aircraft crash. This load case leads the way with regard to the earthquake load case. At present, a corresponding delta analysis is underway to verify the robustness of the plant against an earthquake that is one intensity level stronger (0.1 g) than the design earthquake.	N-13 - N-17, N-19, N-20, N-22, N-23	done	
KKK/ BWR	7	Review of the instrumentation in the area of the spent fuel pool. Irrespective of the fact that the current plant state provides a sufficiently long grace period for re-establishing spent fuel pool cooling, an additional wide-range level measurement has been installed for providing diverse level measurement.	N-20	done	
KKK/ BWR	8	No longer relevant for the present plant state. Hydrogen releases due to radiolysis are no longer to be expected in the current post-operational phase even under accident conditions.	N- 25, N-26	done	
KKP 1/ BWR	1	Statement on the maintenance of the electricity supply on the basis of a safety analysis. An additional mobile emergency power generator set has been obtained. The supervisory authority is in the act of checking whether further information is needed. (BW[48] 1-3)	N-1, N-2, N-19	done	[49]
KKP 1/ BWR	2	Statement on fuel cooling on the basis of a safety analysis. The diverse heat sink is a well. (BW 5-6)	N-3, N-12	done	

48 Numbers indicated refer to the serial number in the Action Plan of Baden-Wurttemberg (BW), as at 31 December 2015

49 All dates relating to the GKN I, GKN II, KKP 1 and KKP 2 nuclear power plants correspond to the Action Plan of Baden-Wurttemberg (BW), as at 31 December 2015

Plant/ type	No.	Activity/measure	Related recommen-dation	Status	Planned finalisation
KKP 1/ BWR	3	A statement on additional component cooling system injection on the basis of a safety analysis has been presented. If multiple failures occur, there exists an alternative technical option for heat removal from the spent fuel pool. (BW 7-8)	N-4, N-12	done	
KKP 1/ BWR	4	Statement on more stringent requirements for filtered containment venting on the basis of a safety analysis. The recommendation for KKP 1 is irrelevant because the spent fuel pool is located outside the containment. In this context, the new recommendations of the RSK of 15. April 2015 on hydrogen release are also dealt with (N-25, N-26). Due to the plant state, no further measures are required. (BW 17-18)	N-6, N-21, N-25, N-26	done	
KKP 1/ BWR	5	Statement regarding the avoidance of hydrogen accumulations in the case of spent fuel pools situated outside the containment. Owing to the little decay heat output of the fuel assemblies there is no need for action. (BW 22)	N-7	done	
KKP 1/ BWR	6	Measure for injecting into the spent-fuel pool was established. The technical conditions for return feeding and additional injection in to the spent fuel pool in the case of evaporation cooling are given. (BW 11)	N-8, N-22	done	
KKP 1/ BWR	7	Statement on the initiation of emergency measures in the event of a loss of the main control room on the basis of a safety analysis. From the independent sabotage and accident protection system (USUS control centre) it is possible to initiate emergency measures that are relevant for the respective plant state. (BW 19)	N-9	done	
KKP 1/ BWR	8	Equal means of communication have been installed and are ready for operation. (BW 20)	N-10	done	
KKP 1/ BWR	9	No debris formation in case of design earthquake. Additional safety margins in case of beyond-design- basis earthquakes are available. Removal equipment and devices are accommodated diversely. Emergency preparedness is ensured. (BW 21)	N-11	done	
KKP 1/ BWR	10	For the KKP I plant, no CCF potential for the loss of the circulating water return structures was identified. (BW 12)	N-12	done	
KKP 1/ BWR	11	The reassessment of the ultimate and the diverse heat sink has been concluded with positive result. (BW 30)	N-12	done	
KKP 1/ BWR	12	Additional estimates of the safety margins of the auxiliary service water and ventilation systems under extreme weather conditions. Additional requirements as a result of the RSK Statement of 6 November 2013. A statement by the operator is available. The supervisory authority is in the act of checking whether further information is needed. (BW 26)	N-13, N-24	done	
KKP 1/ BWR	13	A robustness analysis was performed and presented. Technical discussion on the robustness analysis necessary. (BW 13-15)	N-13, N-18	done in progress	 2016

Plant/ type	No.	Activity/measure	Related recommen-dation	Status	Planned finalisation
KKP 1/ BWR	14	Accessibility and safety during flooding are ensured. (BW 23-25)	N-15	done	
KKP 1/ BWR	15	An additional injection option into the reactor coolant system is irrelevant for KKP 1 as all fuel assemblies are in the spent fuel pool. (BW 4)	N-20	done	
KKP 1/ BWR	16	Possibility of injection has been established. A statement on evaporation cooling on the basis of a safety analysis has been provided. The technical conditions for return feeding and additional in-jection in to the spent fuel pool in the case of evaporation cooling are given. (BW 10)	N-22	done	
KKP 1/ BWR	17	Statement on the introduction of Severe Accident Manage-ment Guidelines (SAMG) on the basis of a safety analysis. Owing to the low decay heat output in the post-operational phase and only few disturbance scenarios, no potential for the crisis team can be derived from the SAMG. There are operational measures in place at KKP 1 that may be classified as SAMG due to their character. (BW 16)	N-23	done	
KKU/ PWR	1	Assessment of the robustness of the emergency measures regarding heat removal from the spent fuel pool in the event of a station blackout, implementation of emergency measures.	N-1, N-2, N-13, N-22	done	
KKU/ PWR	2	Creation of a diverse source of cooling water.	N-3, N-12	done	
KKU/ PWR	3	Assessment of the consequences of a loss of the ultimate primary heat sink regarding the cooling of the spent fuel pool.	N-3, N-4, N-12, N-22	done	
KKU/ PWR	4	Obtaining and providing mobile pumps and other injection equipment.	N-4, N-20	done	
KKU/ PWR	5	Creation of a permanently installed injection path into the spent fuel pool that is accessible from outside the contain-ment.	N-8, N-22	done	
KKU/ PWR	6	Assessment of the robustness of the emergency measures regarding heat removal from the spent fuel pool.	N-9, N-13, N-22	done	
KKU/ PWR	7	Provision of suitable means of communication to increase the robustness of the communication between crisis team, control room, remote shutdown and control station, and the supervi-sory and disaster control authorities.	N-10	done	
KKU/ PWR	8	Review and improvement of the accessibility of the plant grounds and the plant itself after an earthquake and flooding.	N-11	done	
KKU/ PWR	9	Assessment of the CCF potential for the loss of the circulating water return structures and derivation of measures if neces-sary.	N-12	done	
KKU/ PWR	10	Review of the safety clearances of safety-relevant buildings.	N-13	done	
KKU/ PWR	11	Review of flood protection.	N-15	done	
KKU/ PWR	12	Assessment of the consequences of flooding of the annulus regarding the cooling of the spent fuel pool.	N-16	done	

Plant/ type	No.	Activity/measure	Related recommen-dation	Status	Planned finalisation
KKU/ PWR	13	Examination of the flooding-safe storage of safety-relevant equipment.	N-18	done	
KKU/ PWR	14	Review of the availability of the remote shutdown and control station.	N-18	done	
KKU/ PWR	15	Storage or stockage of equipment for pumping over or transporting secured fuel from depots.	N-19	done	
KKU/ PWR	16	Storage or stockage of fuels and lubricants.	N-19	done	
KKU/ PWR	17	Development of procedures and measures for the prevention and mitigation of beyond-design-basis accidents in the area of the spent fuel pool.	N-22	done	
KKU/ PWR	18	Evaluation of whether the RSK Statement "Assessment of the coverage of extreme weather conditions by the existing design" is relevant for the current plant state. Result: The recommendation is not relevant for the current plant state with little decay heat in the spent fuel pool.	N-24	done	
KKU/ PWR	19	No longer relevant for the present plant state.	N- 25, N-26	done	
KWB A+B/ PWR	1	Within 10 hours, no active measures are necessary with the present plant state. The grace periods in Units A and B are currently more than 7 days until the design temperature of 80 °C is reached in the spent fuel pools. As regards the case of a long-lasting failure of the grid connection, it was found during the course of the review that the fuel stocks for the emergency diesel generator sets are sufficient and are stored in a suitable manner. Notwithstanding, for each Unit there exists a mobile emergency power generator set with 400 kVA including the requisite operating agents and supplementary means at the site. Physically separate feed points have been created in the switchgear for establishing an AC power supply. Accessibility of the installations needed for the execution of the measures under station blackout conditions is ensured. Even in beyond-design-basis events involving the destruction of the plant-internal as well as the external infrastructure can suitable measures be taken in the time available.	N-1, N-2, N-19	done	
KWB A+B/ PWR	2	Cooling of the pool cooling system via the fire-extinguishing system is possible. In addition, mobile (fire-extinguishing) pumps as well as physically separated connection options are available in the annulus for the pool cooling system. Hence accessibility of the rooms is given. There are various options for cooling water intake available (seal well, river Rhine, wells). The cooling water is returned via the seal well. The procedures have been determined (emergency manual, core damage frequency) and can be carried out in the grace periods available.	N-3, N-4, N-8, N-12, N-22	done	
KWB A+B/ PWR	3	No longer relevant for the present plant state.	N-5	done	

Plant/ type	No.	Activity/measure	Related recommen-dation	Status	Planned finalisation
KWB A+B/ PWR	4	With the current plant state, a scenario that would require filtered venting can be excluded. What is only possible is a very slow pressure build-up below the design limits. Notwithstanding the above, filtered venting would still be generally ensured in a station blackout; potential H_2 deflagrations can be excluded.	N-6	done	
KWB A+B/ PWR	5	This recommendation is irrelevant for the Biblis NPP. The spent fuel pool is located inside the containment. Passive autocatalytic recombiners are available inside the containment.	N-7	done	
KWB A+B/ PWR	6	Emergency measures are predominantly initiated on-site. In combination with manual actions on site, fuel pool cooling can also be carried out from the remote shutdown and control station. The existing concept is adequate for the prevailing plant state.	N-9	done	
KWB A+B/ PWR	7	The remote shutdown and control station is located within the grounds of BASF Lampertheim and disposes of all aids needed for disaster control. Means of communication to contact the remote shutdown and control station are available. Communication between the remote shutdown and control stations and the control rooms (twin unit plant) is possible (mobile phone reception (D-Netz), satellite phones, walkie-talkies).	N-10	done	
KWB A+B/ PWR	8	Review and improvement of the accessibility of the plant grounds and the plant itself after an earthquake and flooding: Unimogs, stackers, excavators and wheeled loaders are permanently available in decentralised locations at the site. Machinery is also provided by external contractors.	N-11	done	
KWB A+B/ PWR	9	Blockage of cooling water intake: The Biblis NPP fulfils the assessment criteria of robustness levels 1, 2 and 3 with regard to flooding protection. In low-power and shutdown operation, a considerably smaller amount of coolant is required. Due to the existing provisions of – cleaning system (coarse screen, fine screen, travelling screen machine, mechanical water purification plant, clamshells for sand accumulations). – physical separation of the purification plants – cooling water accumulations in lower-lying strata – daily walk-down of the cleaning lines trains; if necessary, constant manning a complete blockage of the cleaning lines need not be assumed. Due to the long grace periods, further countermeasures can be taken independently. Icing: Icing is no longer relevant to the Biblis NPP: – Water temperatures do not fall below 1 °C according to long-standing statistical records. – Freezing point below 0 °C due to salinization. – Suction from lower-lying strata. As the suction of cooling water is from lower-lying strata, no impairment of the cooling water system needs to be assumed even in the case of postulated icing on the surface of the water. Icing in or on components is recognised in time by administrative measures (e.g. inspection rounds).	N-12, N-15	done	

Plant/ type	No.	Activity/measure	Related recommen-dation	Status	Planned finalisation
		<u>Operability of heat exchangers:</u> Slow blockage can be excluded due to type and inspection. The operability of safety-relevant coolers is monitored by measurements. Sudden blockage due to previous deposition mechanisms is excluded. Even if heat exchangers fail, the protection goals will not be violated due to the existing grace periods. <u>Additional water intake:</u> The availability of water intake locations after a design earth-quake is given (receiving water, seal well, wells).			
KWB A+B/ PWR	10	The safety functions that are still relevant (vital) in the current plant state of “low-power and shutdown operation” of Units A and B of the Biblis nuclear power plant are heat removal from the spent fuel pool and maintenance of subcriticality. They can be ensured by the emergency measures for emergency pool cooling described in the crisis team manual, even in the case of beyond-design-basis impacts. The suitability of these measures for the control of beyond-design-basis scenarios (e.g. station blackout, earthquake, loss of the ultimate heat sink, flooding) were positively assessed. Subcriticality in the spent fuel pool has also been verified for a boron concentra-tion of 0 ppm. No systematic analysis needs to be carried out with the aim to determine the effects of beyond-design-basis external or in-ternal hazards on the existing safety and emergency systems needed for the fulfilment of vital safety functions in Units A and B, which are in low-power and shutdown operation.	N-13, N-14	done	
KWB A+B/ PWR	11	Flooding of the annulus at an order of magnitude that would impair the availability of safety-relevant systems is only con-ceivable in connection with large leaks in the auxiliary service water (VE) system or in the fire-extinguishing (UJ) system. The occurrence of subcritical cracks in these low-energy sys-tems is highly unlikely. Furthermore, the two penetrations of the UJ pipes with large diameters into the annulus are nor-mally isolated in normal operation in the Biblis power plant. Moreover, an accumulation of water in the annulus would be detected in time by the existing monitoring systems. Owing to the long grace periods for Units and B and the fact that, due to the postulate considered here, there is no im-pairment of further installations outside the annulus, it has to be assumed that fuel pool cooling can be re-established by way of the emergency measures described in the crisis team manual so that fulfilment of the protection goals “heat removal from the spent fuel pool” is not at risk.	N-16	done	
KWB A+B/ PWR	12	The crash of a fuel assembly transport cask into the spent fuel pool is practically excluded by the existing precautionary measures regarding hoisting gear and load attaching points. In this recommendation, the crash of a fuel assembly transport cask into the spent fuel pool is to be treated as a postulated event. On the basis of the corresponding analyses, the plant opera-tor concludes that the stability and the necessary leak tight-ness of the spent fuel pool have been demonstrated for the case of a postulated crash of a fuel assembly transport cask into the spent fuel pool from the highest possible height. The	N-17	done	

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		expert organisation consulted by the nuclear supervisory authority reviewed and confirmed the assessment by the plant operator.			
KWB A+B/ PWR	13	With the help of the available equipment it is possible to regain access to the relevant buildings, especially as an immediate re-establishment of fuel pool cooling is not necessary due to the long grace periods. The operability of the emergency measures after the external hazards considered here has been assessed positively. With the current plant state of “low-power and shutdown operation” and the existing grace periods available for implementing the emergency measures described in the crisis team manual in connection with the events considered here (design earthquake, flooding, station blackout, blast pressure wave, loss of ultimate heat sink), no relevant radiological effects are expected that would require any actions from the remote shutdown and control station.	N-18	done	
KWB A+B/ PWR	14	Mobile pumps including injection equipment as well as the necessary stocks of fuel and lubricant are available within the plant grounds and housed in structures that are protected against external hazards. The accessibility of the installations necessary for performing the measures under the postulated boundary conditions has been reviewed and found to be ensured. The stockage of boron is not necessary since it has been demonstrated that subcriticality of the fuel assemblies present in the spent fuel pool is also ensured without any additional boron in the cooling water. The availability of a water source following a design earthquake is given (receiving water, seal well, wells). Permanently installed and physically separated options for injecting water into the components indicated are not necessary in the low-power and shutdown operating state and with consideration of the long grace periods. The options for injecting water (leakage make-up) into the spent fuel pool following an external hazard is ensured by several different emergency measures.	N-20	done	
KWB A+B/ PWR	15	Due to the present “low-power and shutdown operation” state and the very long grace periods until impermissible conditions are reached in the spent fuel pool, it is no longer necessary to postulate fuel damage and hence hydrogen releases or a relevant pressure increase in the containment. After a design earthquake or a station blackout it is possible to initiate counter-measures in time.	N-21	done	
KWB A+B/ PWR	16	Emergency measures for spent fuel pool cooling, alternative cooling or pool/component coolers (TG/TF) or for injection into the pool cooling system (TG) from different locations are permanently installed. The accessibility of the installations necessary for performing the measures under the postulated boundary conditions has been reviewed and found to be ensured. The different variants of emergency pool cooling measures are described in the operating manual as well as in the emer-	N-22	done	

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		gency manual and the crisis team manual. If necessary, additional pool cooling using flexible hoses is possible. In the present plant state, the grace period is more than 7 days until the design temperature of the fuel pool of 80 °C is reached, which means that counter-measures can be carried out. No further verifications of how evaporation cooling is ensured are necessary.			
KWB A+B/ PWR	17	Considering the current “low-power and shutdown operation” plant state and the existing grace periods, the emergency measures described in the crisis team manual for the control of the events considered here are sufficient. According to the operator, SAMGs are neither necessary nor appropriate under these conditions. The general decision logic specified in the crisis team manual for the event of a loss of spent fuel pool cooling in Unit B is suitable as an introduction to the further emergency measures described in the crisis team manual.	N-23	done	
KWB A+B/ PWR	18	The plant operator has presented an assessment of how extreme weather conditions are covered by the existing design. The operator's assessment has shown a high degree of robustness in connection with the fulfilment of the vital safety functions. The expert organisation consulted by the nuclear supervisory authority reviewed and confirmed the assessment by the plant operator.	N-24	done	
KWB A+B/ PWR	19	No longer relevant for the present plant state.	N- 25, N-26	done	