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Convention on Nuclear Safety

Report by the Government of the Federal Republic of Germany for the Second Extraordinary Meeting in August 2012

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INTRODUCTION

The 5th Review Meeting of the Convention on Nuclear Safety (CNS) in Vienna from 4th to 15th April 2011 decided to hold the Second Extraordinary CNS Meeting from 27th to 31st August 2012. This additional meeting serves for the information exchange between the Contracting Parties to the CNS on the status of the evaluation of the lessons learned from the accident at the Japanese Fukushima nuclear power plant (NPP) on 11th March 2011 as well as for the description of projects and their implementation aimed at further improving the safety of NPPs and the minimisation of the risk associated with their operation. This Extraordinary Meeting represents an intermediate step on the way to the 6th Review Meeting in April 2014 when the Contracting Parties are to report comprehensively and give an account of the measures they have taken to ensure safety in the light of the evaluation of the Fukushima accident.

The Second Extraordinary Meeting is a topic-oriented meeting with the focus on specific topics and not on the rendering of accounts by the Contracting Parties. The General Committee of the Convention predefined six topic areas, which are addressed with respect to the Federal Republic of Germany in this written report provided by the Contracting Party of Germany:

1. External Events
2. Design Issues
3. Severe Accident Management and Recovery (On Site)
4. National Organisations
5. Emergency Preparedness and Response and Post-Accident Management (Off Site)
6. International Cooperation

The report in hand thus represents a contribution to the general discussion of the six topics of the Extraordinary Meeting in the predefined topic areas. The report is also based on the predefined structure.

Under the main headings of the respective topic, first of all brief descriptions of the circumstances before the Fukushima accident are given. This is necessary in order to enable the reader to get an overall picture of the circumstances applying to Germany with respect to that particular topic since the subsequent sections only describe the actions taken or planned in the wake of the Fukushima accident. Further detailed information can be obtained from the German CNS report to the 5th Review Meeting [CNS-08]. Descriptions relating to the circumstances before the Fukushima accident are printed in blue background to facilitate the reader's comprehension.

According to the predefined structure, the (planned and implemented) analyses and activities carried out for each topic after the Fukushima accident are initially discussed in general. These are followed by descriptions of the activities performed by the operators and the nuclear regulators. The respective topics are then concluded by a synoptic table.

The accident at the Japanese Fukushima NPP on 11th March 2011 and its severe cosequences, triggered by a strong earthquake and subsequent tsunami, has led to a profound change in the peaceful use of nuclear energy in Germany.

Immediately after the event, measures were taken for the protection of the German population from the possible radiological effects of the accident (especially with regard to international passenger and goods traffic) as well as measures at regulatory and political level concerning the review of the safety of the operating German NPPs and the future use of nuclear power in Germany. There was an intensive debate going on within the Federal Government, the German political parties and the German public about the necessary conclusions to be drawn from the Fukushima accident and the experience so far with the peaceful use of nuclear power.

The Federal Government and the Prime Ministers of the Länder with NPPs in operation decided on 14th March 2011 to review the safety of all NPPs in Germany in the light of the events in Japan. They furthermore decided to shut down the seven oldest German NPPs for a period of three months. These decisions were a manifestation of the priority of nuclear safety.

The independent German Reactor Safety Commission (in Germany abbreviated as RSK), which is composed

of renowned experts and advises the Federal Government on nuclear safety issues, was tasked with defining the scope and eventually assessing the results of the safety review of all German NPPs, with the review taking the form of a test of the robustness of the plants. According to the Catalogue of Requirements drawn up by the RSK [CNS-10] for the plant-specific review of the German NPPs, it had to be examined to what extent the general safety objectives of "reactivity control", "cooling of fuel assemblies in the reactor pressure vessel as well as in the fuel pool" and "limitation of the release of radioactive substances (maintaining barrier integrity)" were fulfilled in the event of impacts beyond the design requirements applied so far. To assess the robustness of the plants, three degrees of robustness defined specifically for each topic were introduced. The examinations focused in particular on seismic and flooding events with consideration of certain postulates (e.g. station blackout, long-lasting loss of off-site power, loss of the auxiliary service water), prevention and accident management measures, and aggravated conditions for accident management measures. The examinations also looked at man-induced hazards such as aircraft crashes, pressure blast waves or terrorist attacks as well as possible impacts by neighbouring units. The safety review was carried out by the operators and assessed by the RSK on the basis of the documents provided by the nuclear regulatory authorities of the Länder and by expert organisations

Summarising the results, the RSK concluded in its statement on 16th May 2011 that compared with the Fukushima NPP, a higher level of precaution can be ascertained for German plants regarding the electricity supply and the consideration of external flooding events [CNS-11]. Further robustness assessments showed that there is no general result for all plants in dependence of type and age. Plants that originally had a less robust design were backfitted with partly autonomous emergency systems to ensure vital functions. This selectively led to evidentially high degrees of robustness of older plants. The RSK showed up a further need for examination and assessment.

At the beginning of April, the Federal Government set up a so-called Ethics Commission on "Safe Energy Supply" with the aim to bring about a consensus within society on the country's future energy supply and a debate about the risks involved in the use of nuclear power. This commission was composed with public figures from politics, industry, society and the churches. After two months of discussion and with knowledge of the results of the RSK's safety review (in Germany abbreviated as RSK-SÜ), this ethics commission presented its recommendations on 30th May 2011 [CNS-12]. In them, it comes to the conclusion that the reality of a reactor accident has a substantial influence on the perception of the risks involved in the use of nuclear power. The possible inability to control an accident was therefore of central relevance in the national context. Hence, the aim was to restrict the use of nuclear power for the commercial generation of electricity as far as possible and to abandon nuclear power generation completely within a decade. This withdrawal was evaluated as being possible as there are alternatives available that had less risks involved.

On the basis of the available results of the examinations and discussions, the Federal Government passed a draft law on 6th June 2011 according to which eight NPPs lost the entitlement for power operation. It was also decided that the remaining nine NPPs should be shut down permanently step by step by the year 2022. On 30th June 2011, the Bundestag (federal parliament) adopted by recorded vote with a large majority the "Thirteenth Act on the Amendment of the Atomic Energy Act", which regulates the termination of the use of nuclear power for electricity generation. On 8th July 2011, the Bundesrat (federal council) decided not to request that the Mediation Committee be convened. The Act came into force on 6th August 2011.

At European level, the European Council had declared on 24th/25th March 2011 that "the safety of all nuclear installations in the EU should be reviewed by means of a comprehensive and transparent risk and safety assessment ("stress test")". The methodology, the scope and the sequence plan for the examinations for these EU stress tests were developed by the European Nuclear Safety Regulators Group (ENSREG); The ENSREG declaration was published on 25th May 2011. Detailed requirements for the contents and structure of the National Reports as well as for the Peer Reviews that were conducted during the spring of 2012 were adopted by ENSREG on 11th October 2011.

The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), the competent Länder ministries, the expert organisations and the operators of the German NPPs agreed on 30th June 2011 upon the modalities for the performance of the EU stress test for the German NPPs. This date is considered at the same time as the reference date for the plant state "power operation" of all 17 German NPPs including those plants that were shut down for three months as well as for the plant state "dismantling" of the Obrigheim NPP where fuel assemblies are still in storage. Germany submitted the demanded interim report at the due date on 15th September 2011 and the final report (National Report on the EU Stress Test) at the due date on 31st December 2011 [CNS-13] to the European Commission.

In Germany, this EU stress test was carried out in addition to the RSK-SÜ already described above. It shows that for the three central topics (external events, loss of offsite power and loss of the main heat sink, accident management measures), conservative and robust design requirements were already fulfilled when the plants were built. The RSK had already found out that some of the German plants feature high degrees of robustness with regard to specific chosen aspects. However, the National EU Stress Test Report also shows possibilities for the safety-related improvement of the power plants, especially in the area of accident management, which the regulatory authorities will follow up. The BMU has asked the RSK to take the results of the EU stress test into consideration when deliberating further on the possible improvement of the safety of the German NPPs. Apart from examinations in connection with the three focal topics

- external events,
- loss of off-site power and loss of the ultimate heat sink
- accident management measures

and the influence of accidents in neighbouring plants, the National EU Stress Test Report also describes the RSK statements on man-induced hazards, such as aircraft crash, blast pressure wave outside the plant, and terrorist attacks. What is described thus goes beyond the predetermined scope within the EU.

The National Report is available from the BMU's website at http://www.bmu.de/atomenergie_sicherheit/doc/48235.php and additionally – like the reports of the other EU Member States – at www.ensreg.eu and is thus accessible to the general public. Moreover, the German nuclear power plant operators have published their reports relating to the EU stress tests on their own websites; the corresponding links are contained in the Annex to this report.

Germany will report on the progress and results of the further analyses and on the consultations regarding the national need for action to improve the safety of the nuclear installations in Germany at the 6th Review Meeting under the Convention.

Brief summary

The nuclear consequences of the earthquake disaster in Japan represent a profound change for the peaceful use of nuclear power, also in Germany. In the light of these events, the German Federal Government, together with the Prime Ministers of the Länder in which NPPs are operated had reviewed the safety of all German NPPs by the German Reactor Safety Commission in close collaboration with the competent nuclear regulatory authorities of the Länder and, through an Ethics Commission on "Secure Energy Supply", also started a dialogue among the German society on the risks involved in the use of nuclear power and on the possibility of an accelerated transition to the age of renewable energies.

Taking into account the results of the Reactor Safety Commission and the Ethics Commission on "Secure Energy Supply" as well as the absolute priority of nuclear safety, the Federal Government decided to terminate the use of nuclear power at the earliest possible date. The amendments in the Atomic Energy Act that went into force in August 2011 induce the progressive abandonment of electricity generation by NPPs in Germany by the end of 2022 at the latest.

Germany took an active part in the assessment of the robustness of the NPPs in Europe (EU stress test) under the leadership of the European Nuclear Safety Regulators Group (ENSREG). The results of these reviews show that the German plants partly have considerable safety margins and that additional precautionary measures have been taken in order to prevent (preventive measures) or limit (mitigative measures) the effects of the beyond-design-basis events considered in the reviews.

Based on the results of the plant-specific reviews, the RSK has derived first recommendations for further examinations. Some plant-specific improvement measures are already in implementation or planned. The results of the EU stress test will be taken into account in future RSK recommendations.

On behalf of the BMU, the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) prepared an Information Notice on the conclusions drawn from the Fukushima accident for German NPPs. The recommendations also include measures for a further improvement of the control of beyond-design-basis events. The recommendations essentially concern the electrical energy supply, residual-heat removal, and accident management procedures.

As regards emergency preparedness measures, the Federal Environment Ministry has initiated a working group of the Commission on Radiological Protection (in Germany abbreviated as SSK) that carries out a review of the German regulations for emergency preparedness on the basis of the experience feedback from the Fukushima accident. Corresponding changes and measures will be defined once the results are available.

CONTENT

1 TOPIC 1 – EXTERNAL EVENTS

When the German NPPs were built, the requirements for the design and the protection measures against external hazards were based on the requirements of the respective applicable nuclear regulations. In cases where the regulations did not yet contain any detailed requirements, concrete specifications were sometimes made in the licensing procedure. Essential development steps are outlined in the following.

The construction of all NPPs included design provisions against site-specific natural hazards such as wind and snow loads, flooding, and earthquakes. Both nuclear safety standards and conventional building codes were applied. Depending on the cooling concept of the plant, the system design also resulted in requirements for the safety-relevant cooling water supply. Here, it was demonstrated for the respective site conditions that this cooling water supply was ensured even under possible adverse conditions, such as low river water levels or the failure of a barrage.

Design against flooding

Since 1982, the requirements for flood protection measures have been specified in nuclear safety standard [KTA 2207], revised in the years 1992 and 2004. According to these requirements, the design flood to be assumed is a flood that will occur once in 10,000 years (exceedance probability 10^{-4}/a). According to this rule, a permanent flooding protection has to exist to withstand the design flood level. Deviating from this, it is possible for individual areas of the plant that protection against the difference between the water level of a flood with an exceedance probability of 10^{-2}/a and the design basis water level of 10^{-4}/a may be provided by temporary measures if there is a sufficient advance warning time during which the temporary flood protection measures can be performed.

The sites of the nuclear power plants are mostly located inland at rivers and, in some cases, at estuaries with tidal influences. In most of the cases, sites have been selected which are located sufficiently high. In all other cases, the structures for activity retention of those housing safety-relevant systems or plant components were sealed for water tightness and were built with waterproof concrete. Furthermore, the openings (e.g. doors) are located above the level of the highest expected flood. If these permanent protective measures should not be sufficient, mobile barriers are available to seal the openings.

The re-examinations of the flood protection carried out by order of the BMU between 2000 and 2002 showed that the plant- specifications regarding the design basis flood as well as the technical and administrative protection measures are in principle in agreement with the regulations that were valid at the time. However, the results of the examinations also reveal that different methods had been applied at the individual plants to determine the design basis flood and also to maintain the flood protection measures. The specific protection measures at the different sites depend strongly on the respective topographic conditions. There is thus a heterogeneous picture of the individual planned or implemented measures. For example, for some NPPs that are sited directly next to a river, it may be that there could be

an island situation already in the event of a millennial flood, for which corresponding organisational and administrative measures are provided.

To standardise procedures in connection with flood protection, the nuclear safety standard [KTA 2207] was revised and has been available in the updated version since in November 2004. The latest changes compared with the previous version concern in particular the specification and determination of the design basis flood, which is now consistently based on an exceedance probability of 10^{-4}/a. The new version of the safety standard is used as design criterion for deterministic safety-related reviews, e.g. as part of the safety review to be performed pursuant to § 19a AtG.

Design against earthquakes

Since 1990, the design against earthquakes is based on a design basis earthquake (formerly called "safe shut-down earthquake") in accordance with safety standard [KTA 2201.1]. The so-called operating basis earthquake, formerly to be considered additionally according to the previous version of 1975, was replaced by an "inspection earthquake" where only the plant condition has to be checked. The design basis earthquake has the largest intensity that, under consideration of scientific findings, could occur in a wider vicinity of the site (200 km radius). Depending on the site, the intensity of the design basis earthquake varies between less than VI and a maximum of VIII on the MSK scale. In the power plants of older construction lines, the seismic qualification of civil structures, components and plant equipment was partly based on simplified (quasistatic) methods which delivered the basic values for the corresponding design specifications. In more recent nuclear installations the newly developed dynamic analyses were also applied.

In the case of some plants at sites with relevant seismic influence, re-assessments were carried out due to the progress in the development of methods for the determination of the seismic impacts and of design verification procedures. The reassessments of the designs of components showed in general that if precise seismic impacts and modern verification procedures are considered, the system designs of the installations sometimes have considerable safety margins against seismic loads. In plants where a need for upgrading was identified nevertheless, comprehensive safety-related backfitting was performed on the basis if this reassessment. Furthermore, within the framework of the erection of on-site interim storage facilities, new seismic risk analyses were carried out for all sites. Moreover, earthquake PSAs were performed for five NPPs at four different sites.

The safety standard [KTA 2201.1] was revised until the end of 2011, with the new version being passed and published in January 2012. One essential addition is that the seismic risk of a site in the form of the design basis earthquake now has to be determined both by deterministic (DSHA, deterministic seismic hazard assessment) and probabilistic methods (PSHA, probabilistic seismic hazard assessment). Before, safety standard KTA 2201.1 only demanded the application of the deterministic methods.

1.1 A short discussion or overview of the topic analysis performed by the Contracting Party

By order of the Federal Environment Ministry, the Reactor Safety Commission prepared a Catalogue of Requirements for a safety review of the German NPPs, abbreviated as RSK-SÜ. The RSK-SÜ looked at the question of whether the safety functions needed to maintain the safety objectives of the respective NPP under review would also be ensured under loads going beyond those of the licensing requirements.

At European level, the European Council ordered a review of the safety of all nuclear installations in the EU by means of a comprehensive and transparent risk and safety assessment ("EU stress test"). The aim of the EU stress test is a reassessment of the safety of NPPs against the background of the events in Fukushima. For this purpose, the design of the plants – including the robustness within the design – was reviewed and, on this basis, the existing safety margins of the plants in the beyond-design basis area (i.e. the robustness in the beyond-design basis area) were determined. The objective was to examine whether in the event of a transgression of the design limits a loss of fundamental safety functions or any severe damaging of the fuel (in the reactor pressure vessel or in the fuel storage) was to be postulated.

The analyses for the RSK-SÜ and the EU stress test were carried out by the operators. The Länder authorities reviewed and assessed the information provided by the operators. Both in the case of the safety review and the EU stress test, the results were compiled by GRS on behalf of the BMU and evaluated by the RSK and/or the BMU.

1.2 Activities performed by the operator

In its statement on the RSK-SÜ, the Reactor Safety Commission confirmed to the BMU that in the area of external hazards, "the effects to be considered according to the state of the art in science and technology in connection with occurrence frequencies of approx. 10^{-3}/a, especially those that may lead to "cliff edge" effects, are taken into account throughout in the designs of German nuclear power plants" and that "the electricity supply of the German nuclear power plants is more robust throughout than at Fukushima I."

In their safety reviews the German operators came to the conclusion that beyond-design-basis events due to natural hazards can practically be excluded in their NPPs. With the 12th amendment of the Atomic Energy Act (AtG), the legislator has established by law a duty of care in § 7d AtG according to which the operators are required to put into effect safety provisions that are correspondingly developed, suitable and appropriate for making a not merely slight contribution to further precaution against risks for the general public. It was against this background, too, that the operators assessed the recommendations of the RSK-SÜ and derived corresponding measures.

Due to the high degree of robustness of the German plants not only in the design but also in the beyond-design-basis range and thanks to the balance of the defence-in-depth concept, further room for improvement is seen essentially in the area of accident management measures. Should any plant improvements ensue, these will be carefully specified with regard to their concepts and technical as well as organisational aspects and will subsequently be implemented. Against this background it is also necessary to transfer the direct plant-specific measures that were taken immediately after the events at Fukushima and which are described in the following sections into an integrated overall concept, needed in an adapted form.

The general objective at present is therefore the extension of the plant-specific accident management concepts as part of a sustainable integrated overall concept with the aim to increase the robustness of the plants, i.e. the already existing safety margins, beyond the design basis.

The measures include amongst other things a concept for the extended availability of the assured direct-current (DC) power supply as well as of the battery support by additional emergency power generators, a concept for a further improvement of the management of lubricants and operating materials for the supply of diesel fuel in the event of a sustained loss of offsite power, verifications of the assured cooling of the spent fuel pool via evaporation cooling, additional emergency measures for external coolant injection into the spent fuel pool, if necessary by means of additional equipment, and the preparation of Severe Accident Management Guidelines (SAMG). The study of the evaporation cooling and integrity of the spent fuel pool under boiling conditions, which is necessary in connection with spent fuel pool injection, is now available, as part of an integrated concept to increase robustness against a station blackout (SBO) and long-lasting loss of offsite power by means of mobile emergency power generators. An adaptation of these concepts and perhaps further measures may have to be provided depending on the insights that may yet be gained from the ongoing follow-up analyses of the Fukushima accident.

1.2.1 A short discussion or overview of the actions taken or planned by the nuclear power plant (NPP) operator to address the topic

Earthquake

The design basis earthquake is controlled as per design; hence no mobile equipment is necessary. Owing to the conservative design of the systems in line with the requirements, far-reaching safety margins exist even for the control of effects that may be triggered by a beyond-design-basis earthquake. Hence there is no need for a change to existing installations or plant components. Owing to the robustness of the plants, no additional precautions need to be taken, either.

Nevertheless, there are plant-specific examinations as to what extent safety margins can be increased by appropriate additional installations and measures to protect vital functions. These include amongst others the measures mentioned in section 1.2 as part of the integrated overall concept.

After the Fukushima accident, some plants responded immediately by taking direct action. For example, the following immediate measures were planned or realised at some plants to increase robustness:

- obtaining mobile emergency power generators and/or contractual assurance of the provision of (further) generators on demand
- review of the conservativeness of the earthquake risk at the site and correspondingly derived characteristic values.

Flooding

Owing to the high degree of robustness, which partly goes far beyond the design basis area, no further measures to increase robustness against flooding are necessary for most PWRs and BWRs. There are plant-specific examinations as to what extent safety margins can be increased to protect vital functions and accessibility of the plant's sites can be improved by appropriate additional installations and measures. There are no further examinations of sites where due to the topography and plant design it is possible to exclude that there will be any impairments of accessibility and of the effectiveness of vital functions.

After the Fukushima accident, some plants responded immediately by taking direct action. For example, the following immediate measures were planned or realised at some plants to increase robustness:

- improvement of the accessibility of the sites during long-lasting flooding, e.g. by obtaining boats
- obtaining mobile emergency power generators and/or contractual assurance of the provision of (further) generators on demand
- additional structural waterproofing of buildings housing safety-relevant components against even higher flood levels.

Tsunami, other external hazards

Owing to the high degree of robustness of the systems in line with the requirements by the conventional design and the design against blast pressure waves and aircraft crash, there exist far-reaching safety margins to control external hazards. Hence there is no need for a change to existing installations or plant components. No additional precautions need to be taken, either.

The influence of extreme weather conditions on the safe operation of the plants was already examined after the once-in-a-century summer of 2003. These examinations with regard to wind and snow loads, low temperatures and icing, high water and air temperatures, flooding, groundwater, extreme rainfall as well as lightning strike have not been identified by this re-assessment to require any adaptation.

1.2.2 Schedules and milestones to complete the operator's planned activities

The implementation of the planned activities will take place within the framework of the nuclear licensing and supervisory procedure.

Statements on the Information Notice (WLN) prepared and issued by GRS on the conclusions drawn from the Fukushima accident are made to the competent supervisory authorities, individual aspects were adopted into the operators' working programmes in order to prepare an integrated overall concept for the extension of the plant specific accident management concepts. Moreover, issues from the peer review process in con-nection with the EU stress test as well as individual aspects from the national reports of other countries are currently being assessed by all operators, both generically and plant-specifically.

1.2.3 Preliminary or final results of these activities, including proposals for further actions

Once the integrated overall concept with consideration of the already implemented immediate measures and the subsequent actions taken is available, the safety gain for each plant will be assessed. The implementation of the overall concept will be done plant-specifically within the framework of the licensing and supervisory procedure, taking the results of the consultations within the RSK into account.Activities performed by the regulator

1.3 Activities performed by the regulator

1.3.1 A short discussion or overview of the actions taken or planned by the regulatory body to address the topic

RSK Safety Review

The RSK-SÜ looked into the question of whether the safety functions to warrant the safety objectives of the respective NPP under review would also be ensured under loads beyond those stipulated in the licensing requirements. The safety review was carried out by the operators and evaluated by the RSK.

The RSK is of the opinion that regarding the seismic design, there exist in part considerable safety margins and that the arguments brought forward by the operators in this respect are in principle plausible. This assessment is based among other things on the conservatism in the calculation chain and the insights gained from the seismic PSAs carried out for individual plants so far. The RSK sees the potential for safety margins to the extent of one intensity level. However, it was not possible to derive explicitly from the evaluated documents whether all conditions of low-power and shutdown operation were considered (e.g. flooded reactor cavity during refuelling). The RSK considers it necessary to start discussing this topic. It will include the topic in its working programme and address the resulting issues.

For most of the plants, the RSK assessment has shown that significant safety margins exist as per design to withstand the once-in-ten-thousand-years flood postulated by the current state of the art in science and technology. The extent of the safety margins dif-fers

from plant to plant. Further examinations are necessary for a final assessment. With the flood levels considered here, accessibility of the sites of several plants is restricted. For some plants, the sites will already be flooded by the design basis flood. In such cases, the RSK recommends that it should be reviewed within the framework of the supervisory procedure whether the safety of the plant in the event of a longer-lasting flood will be ensured.

Further procedure by the RSK

Based on the results of the RSK safety review of the German NPPs and against the background of the events at Fukushima Daiichi (Japan), the RSK plans to carry out more detailed analyses of individual aspects of the topic areas earthquake and flooding.

KTA Nuclear Safety Standards

The KTA subcommittee on "Programme and Fundamental Issues" and the KTA Steering Committee have discussed the need to amend some KTA Safety Standards in the light of the events at Fukushima. Regarding external hazards, the following Safety Standards were identified as requiring further discussion.

- KTA 2201 "Design of Nuclear Power Plants against Seismic Events"
- KTA 2207 "Flood Protection for Nuclear Power Plants"
- KTA 2501 "Structural Waterproofing of Nuclear Power Plants"
- KTA 2502 "Mechanical Design of Fuel Assembly Storage Pools in Nuclear Power Plants with Light Water Reactors"

The review and amendment of KTA 2201 "Design of Nuclear Power Plants against Seismic Events" was concluded (publication of the new version of the Safety Standard in January 2012). This means that for the first time the nuclear regulations stipulate that the sites of nuclear power plants in Germany have to be subjected not only to deterministic hazard analyses – as used to be the case so far – but also at equal weight to probabilistic hazard analyses.

EU stress test

No additional measures were derived for the power plants on the basis of the robustness examinations carried out as part of the EU stress test.

The BMU has initiated further reviews beyond the activities described. Their results will form the basis for considering measures (e.g. new requirements and review of the safety standards) to improve the safety of German NPPs.

Information Notice (WLN)

GRS was commissioned by the BMU to prepare an Information Notice. This Information Notice contains the following recommendations with respect to external hazards:

1. Specification of the design basis earthquake has to be reviewed according to KTA 2201.1 (version 2011–11)

2. If new findings on the design basis earthquake hazard become available, the related verifications of the seismic design have to be examined and carried out anew, if necessary.

3. It has to be ensured that objects and equipment not subject to seismic classification have to be arranged, fixed, stacked or positioned in such a way that in case of an earthquake no safety-relevant installations will be damaged by falling off or overturning, or that radioactive material will be released. These objects and equipment include temporary set-ups, ladders, workshop vehicles and installations that installed in or on ceilings or on walls. Appropriate regulations should be included in the plant operating procedures.

4. The gantry crane at the intake structure and the associated infrastructure like e.g. tracks should be examined as to whether these can be damaged in case of an earthquake. If this is the case, the gantry crane and associated infrastructure have to be designed against earthquakes, or a suitable alternative in the form of a mobile crane has to be available at the site to re-establish the function of the intake structure after an earthquake.

5. In case of an earthquake, rubber expansion joints and other flexible pipe connections can be stressed extremely. These can fail if there are any pre-existing defects, e.g. due to ageing, and lead to the flooding of safety relevant installations. Thus, these components have to be included into ageing monitoring, if not yet done.

6. The seismic instrumentation has to be able to record several subsequent earthquakes (fore-, main- and aftershocks).

7. Loads that safety-relevant components may have suffered during an earthquake have to be considered in the ageing management.

1.3.2 Schedules and milestones to complete the regulatory body's planned activities

RSK

The RSK is currently preparing further recommendations. These are to be available in the autumn of 2012.

KTA

In order to be able to react quickly to the events at Fukushima, an extraordinary meeting of the Seismology Working Group of the Nuclear Safety Standards Committee was convened on 12th April 2011. It was declared that there was no further need for change as regards KTA 2201.1. All recent results of the accident analysis of the Fukushima accident had been considered. The Safety Standard was adopted in November 2011 and published in January 2012.

The committees of the KTA have been dealing with the events at Fukushima since May 2011 already and continue looking at any resulting issues.

1.3.3 Preliminary or final results of these activities, including proposals for further actions

The first recommendations of the RSK and the Information Notice have created the framework for the implementation of first improvement measures by the operators. Further RSK recommendations are planned by the autumn of 2012. The BMU will coordinate the implementation of the necessary measures with the nuclear regulatory authorities of the Länder.

1.4 Synoptic table of the activities described in 1.2.1, 1.2.2, 1.2.3, 1.3.1, 1.3.2 and 1.3.3

	Activities performed by the operator			Activities performed by the regulator		
Activities	(Section 1.2.1) Activities • performed? • ongoing? • planned?	(Section 1.2.2) Schedules or milestones to complete the planned activities	(Section 1.2.3) Available results • yes? • no?	(Section 1.3.1) Activities • performed? • ongoing? • planned?	(Section 1.3.2) Schedules or milestones to complete the planned activities	(Section 1.3.3) Available conclusions • yes? • no?
Topic 1 – External Events						
Extended availability of the assured direct-current (DC) power supply as well as of the battery support by additional emergency power generators as part of an integrated overall concept	ongoing		no			
Further improvement of the management of lubricants and operating materials for the supply of diesel fuel in the event of a sustained loss of offsite power as part of an integrated overall concept	ongoing		no			
Verifications of the assured cooling of the spent fuel pool via evaporation cooling as part of an integrated overall concept	ongoing		no			

	Activities performed by the operator			Activities performed by the regulator		
Activities	(Section 1.2.1) Activities • performed? • ongoing? • planned?	(Section 1.2.2) Schedules or milestones to complete the planned activities	(Section 1.2.3) Available results • yes? • no?	(Section 1.3.1) Activities • performed? • ongoing? • planned?	(Section 1.3.2) Schedules or milestones to complete the planned activities	(Section 1.3.3) Available conclusions • yes? • no?
Topic 1 – External Events						
Additional emergency measures for external coolant injection into the spent fuel pool, if needed with additional equipment, as part of an i ntegrated overall concept	ongoing		no			
Preparation of Severe Accident Management Guidelines (SAMG) as part of an integrated overall concept	ongoing		no			
Obtaining mobile emergency power generators and/ or contractual assurance of the provision of (further) generators on demand	performed		yes			
Review of the conservativeness of the earthquake risk at the site and correspondingly derived characteristic values	performed		yes			

	Activities performed by the operator			Activities performed by the regulator		
Activities	(Section 1.2.1) Activities • performed? • ongoing? • planned?	(Section 1.2.2) Schedules or milestones to complete the planned activities	(Section 1.2.3) Available results • yes? • no?	(Section 1.3.1) Activities • performed? • ongoing? • planned?	(Section 1.3.2) Schedules or milestones to complete the planned activities	(Section 1.3.3) Available conclusions • yes? • no?
Topic 1 – External Events						
Improvement of the accessibility of the plant's sites during longlasting flooding, e.g. by obtaining boats	performed		yes			
Additional structural waterproofing of buildings housing safety-relevant components against even higher flood levels	largely performed		yes			
Operators' responses to the Information Notice (WLN) on Fukushima	ongoing		no			
Updating of KTA Safety Standards	ongoing			ongoing		
RSK recommen-dations				ongoing	Autumn of 2012	no
Preparation and release of the Information Notice (WLN) on Fukushima				performed		no

2 TOPIC 2 – DESIGN ISSUES

The Atomic Energy Act (AtG) [1A-3] elevates the protection against damage as required according to the state of the art in science and technology to a major criterion for granting of a licence. For this damage precaution, a concept of safety provisions becoming effective successively reflects today's state of the art in science and technology. This is referred to as defence in depth concept. The basic features of the concept are specified by the provisions of the nuclear rules and regulations. The Safety Criteria [3-1] with their supplementing interpretations [3-49] cover the design for normal operation, abnormal occurrences and the control of design basis accidents.

At the first level of defence, the defence in depth concept places high demands on the design and quality of the technical systems and equipment as well as on personnel qualification in order to ensure a plant operation as failure-free and environmentally compatible as possible. At the second level of defence, the concept includes measures for the control of abnormal occurrences and for the prevention of design basis accidents. The third level of defence comprises technical systems and measures for the control of design basis accidents. For these, the German rules require high reliability.

Section 49 of the Radiation Protection Ordinance (StrlSchV) [1A-8] defines specific planning values to which the release of radioactive material in case of design basis accidents has to be limited. The design basis accidents considered in the design of the last licensed nuclear power plants are specified in the accident guidelines [3-33.1].

The nuclear rules and regulations also define requirements for precautions against events beyond the original design basis accidents (beyond-design-basis accidents of levels of defence 4a to 4c). These are, among others:

- very rare events (e.g. ATWS, emergency situations such as accidental crash of a military aircraft, gas cloud explosion),
- events with multiple failure of safety systems and equipment (e.g. station black-out), as well as
- accidents with core damage.

In general, the priority of all protection measures is always first to prevent design basis accidents/beyond-design-basis accidents. Wherever possible, the principle applies: to prevent damage instead of control damage that has already occurred. The contents of levels of defence 4b and 4c are specified in the RSK guidelines for pressurised water reactors [4-1] and supplement by further RSK recommendations. For such events, damage preventing (preventive) and damage mitigating (mitigative) measures were provided. An overview of major backfitting measures is given in Table 2-1.

Moreover, the Safety Criteria [3-1] stipulate that organisational and technical measures inside and outside the nuclear installation are to be provided by way of precaution to identify and mitigate the consequences of accidents.

The concept for prevention and control of design basis accidents is implemented at all German nuclear power plants. The main requirements of the safety criteria were already considered in the design of the first construction lines. In the early eighties, the RSK guidelines were revised and, above all, new requirements for the separation of redundancies were included. These requirements could be considered in the design of the nuclear installations that were in the planning phase at that time. At the already existing nuclear installations, backfitting measures, some of them extensive, were performed to achieve this safety standard there. (see Table 2-1).

Table 2-1: Major backfitting measures in nuclear power plants (according to construction line)

	Objective of improvement	PWR construction line				BWR const. line	
	Improvement measures	1	2	3	4	69	72
1.	Enhanced reliability of specified normal operation						
	Additional off-site power supplies	X	X	–	–	X	–
2.	Enhanced effectiveness and reliability of safety systems and equipment						
	Additional emergency diesel generators	X	–	–	–	X	X
	Additional high-pressure and low-pressure emergency core cooling systems (PWR)	X	–	–	–		
	Extension of emergency core cooling systems/additional injection lines (PWR)	X	X	–	–		
	Technical improvement of the high-pressure/low-pressure interfaces	X	X	X	X	X	X
	Independent emergency core cooling systems/new diversified emergency core cooling system (BWR)					X	X
	Additional emergency feedwater systems	X	X	–	–	–	–
	Technical improvement of safety-relevant components to withstand design basis accidents	X	X	–	–	X	–
	Additional valves for containment isolation (BWR)					X	–
	Diversified pilot valves for safety and relief valves (BWR)					X	–
	Diversified pressure relief valves (BWR)					X	X
3.	Improvement of safety during specific emergency situations						
	Emergency systems	X	X	–	–	X	–
4.	Mitigation of fire consequences						
	Physical separation by installing new systems in separate buildings	X	–	–	–	X	–
	Additional fire fighting systems	X	–	–	–	–	–
	Backfitting of fire fighting systems	X	–	–	–	–	–
	Technical improvement of fire dampers and fire partitions	X	X	–	–	–	–
	Additional fire dampers	X	–	–	–	X	–
5.	Improvement of barriers						
	New pipes of improved material for main steam, feedwater and nuclear auxiliary systems (BWR)					X	–
	Optimised materials for steam generators (PWR)	X	–	–	–		
	Removal of the former pressurised bearing water system with its connections outside of the containment (BWR)					X	–
6.	Accident management						
	Improvement of technical equipment for damage prevention	X	X	X	X*	X	X
	Improvement of technical equipment for damage mitigation	X	X	X	X*	X	X

X improvement through backfitting
– already covered by the design
X* in some construction line 4 PWRs partly considered in the designs

Electrical energy supply

The generic requirements for the electrical energy supply in German NPPs are described in KTA 3701. According to this safety standard, all unit generators can supply the safety-relevant consumers with electricity (a system for automatic load rejection to auxiliary station supply exists), and there furthermore exist at least two offsite supply connections (i.e. main and standby grid) that can supply at least all emergency power system trains with electricity. These two connections are functionally separated and have decoupled protection; furthermore, they are connected either to separate grid switchgear systems or to different voltage levels. In case of a challenge, the offsite supply connections are switched on automatically. If the above-mentioned systems are not available, emergency power generators and batteries that are additionally installed on the plant premises ensure the supply of the safety-relevant systems with electrical energy. Moreover, there is at least one other system available to supply at least one residual-heat removal train with electricity. In case of a challenge, it has to be possible to connect this system by manual action (so-called third grid connection).

The requirements for the design of the emergency power generators are described in KTA 3702. According to this safety standard, the emergency power supply system is designed redundantly (n+2) and with protection against external natural hazards in all NPPs. Requirements for the auxiliary systems and the materials used are also fulfilled in line with KTA safety standards or in equal quality. According to a RSK Guideline, a battery capacity of at least two hours has been realised in all NPPs. (It is assumed that within this period, the grid supply to the NPPs can be re-established by black-start-capable power

Table 2-2: Electrical energy supply PWR

Design characteristics	Constr. line 1	Constr. line 2			Constr. line 3	Constr. line 4
	KWO	KWB-A/B	GKN I	KKU	KBR, KKG, KWG, KKP-2	KKE, KKI-2, GKN II
Number of independent off-site power supplies	2	at least 3				
Generator circuit breaker	not applicable	yes				
Station supply in the case of loss of off-site power	not applicable	yes, load rejection to house-load operation				
Emergency power supply	2 trains with 1 diesel each	4 trains with 1 diesel each	4 trains with 1 diesel each + 1 diesel (physically separated)	4 trains with 1 diesel each	4 trains with 1 diesel each (D1 emergency power system)	
Emergency power supply to cope with external hazards	both trains are protected against external hazards	9 connections between both units + 2 trains with 1 additional diesel (RZ)	2 out of 4 trains are protected against exter-nal hazards	2 trains with 1 additional diesel each + 1 additional diesel	4 trains with 1 additional diesel each (additional D2 emergency power system)	
Uninterruptible DC power supply (battery-buffered)	2 trains with ±24 V each	2 trains with ±24 V each + 4 trains with 220 V each	4 trains with 220 V, ±24 V each	4 trains with 220 V, ±24 V each + 2 trains with ±24 V each	4 trains with 220 V, ±24 V each (D1 system) + 4 trains with ±24 V each (D2 system)	
Battery-secured power supply	at least 2 hours					

Table 2-3: Electrical power supply BWR

Design characteristics	Construction line 69				Construction line 72
	KKB	KKI-1	KKK	KKP-1	KRB II-B/C
Number of independent off-site power supplies	at least 3				
Generator circuit breaker	yes				
Station supply in the case of loss of off-site power	yes, load rejection to house-load operation				
Emergency power supply	4 trains with 1 diesel each	4 trains with 1 diesel each	6 trains with 1 diesel each	2 trains with 2 diesels each	3 trains with 1 diesel each + 2 trains with 1 diesel each
Emergency power supply to cope with external hazards	2 trains with 1 additional diesel each (UNS)	2 out of 4 trains are protected against external hazards	2 out of 6 trains are protected against external hazards	2 trains with 1 additional diesel each (USUS)	2 out of 3 trains are protected against external hazards + 1 train with 1 additional diesel (AHRS) + hand-operated connections between both units
Uninterruptible DC power supply (battery-buffered)	2 trains with 220 V, 4 trains with ±24 V each + 2 trains with 220 V, ±24 V each (UNS)	4 trains with 220 V, ±24 V each	6 trains with 220 V, ±24 V each	2 trains with 220 V, ±24 V each + 2 trains with 220 V each, ±24 V (USUS)	3 trains with 220 V, ±24 V each + 2 trains with 220 V, ±24 V each + 1 train with ±24 V (AHRS)
Battery-secured power supply	at least 2 hours				

plants.) Additionally, emergency power generators were installed that are specially protected against external man-made hazards, or existing emergency power generators were fitted with additional protection.

Heat sink

In Germany, the design of the water loops of the cooling and auxiliary systems varies in the different plants. In principle, the regulations demand a (n+2) redundant design for the active components of the safety-relevant cooling systems. Although no regulatory demand exists for a diverse heat sink, some of the plants dispose of an option to remove heat to a heat sink that is independent of the river. To do so, wells or multiple-cell cooling towers are provided.

Corresponding regulations on these can be found i.e. in KTA 3301 “Residual Heat Re-moval Systems of Light Water Reactors” and KTA 3303 “Heat Removal Systems for Fuel Assembly Storage Pools in Nuclear Power Plants with Light Water Reactors”.

2.1 A short discussion or overview of the topic analysis performed by the Contracting Party

RSK-SÜ

With the plant-specific safety review, the RSK has examined the robustness of the German plants against the occurrence of a SBO and also a long-lasting SBO (> 2 hours). It has furthermore examined how robust the plants are during a long-lasting loss of offsite power (> 72 hours).

As regards the SBO, the robustness of the German NPPs at the simultaneous loss of the main grid connection, the standby grid connection, the supply from the plant's own generator, an emergency power generating system fulfilling the requirements of KTA 3701 and 3702 and a further autonomous, short-term-available AC current supply (e.g. assured grid connection or supply from the neighbouring unit) was examined. It was postulated that the failure of the above-mentioned systems would last longer than two hours. As initial plant state, the RSK restricted its examination to power operation.

For several plants (see Tables 2-2 and 2-3), the power supply of the installations necessary from a safety point of view (no emergency system installations) can be ensured for the maintenance of the vital functions via an additional diverse and at least (n+1)-redundantly designed emergency power system that is capable of supplying the vital safety functions with electricity for more than ten hours. At a postulated loss of all emergency power installations (e.g. D1 and D2 systems, see Table 2-2), the necessary safety functions for the maintenance of the safety objectives can be ensured in accordance with the respective existing battery capacities (design requirement: 2 hours) as well as by process-related actions to maintain residual-heat removal that are suited to the then available electricity supply (e.g. fire-fighting pumps).

All plants that are still in operation dispose of at least the required number of emergency power installations which are protected against man-made and natural external hazards (e.g. bunkered and hence protected against aircraft crash, blast pressure wave and flooding).

Furthermore, emergency procedures are in place in all plants to re-establish a sufficient supply of electricity in the event of a loss of the emergency power supply.

In its safety review, the RSK states furthermore that the operators of all PWRs and BWRs have provided information with regard to battery capacities, process-based measures for core cooling, and emergency measures to re-establish electricity supplies. The information on the discharge times of the batteries was so far not sufficient in most cases to assess whether the batteries would be able to supply sufficient electricity to ensure the vital safety-related functions for a longer period – i.e. ten hours or more – in combination with process-based measures in the event of a complete loss of the three-phase current supply.

As regards a long-lasting loss of offsite power (>72 hours), the RSK states in its safety review that the evaluation of the answers provided by the operators showed that either contracts or oral agreements exist about the delivery of auxiliary and operating supplies. There are mostly neither indications on auxiliary and operating supply delivery times, nor of the consideration of damage caused by natural hazards. According to the RSK, in the documents presented the operators point at partly considerable oil and fuel reserves stored on the plant premises. For some plants, this would allow the operation of the emergency diesels for several weeks. Information on the protection of these supplies against natural hazards and on the secured transport is not available, however. With a few exceptions, all plants have access to mobile emergency power generators in the vicinity of the plant. In these cases, the periods until the availability of the mobile emergency power generators are clearly below 72 hours.

EU stress test

Additional to the protection of the plants against external hazards, the safety margins of the plants in connection with the following postulated events were examined as part of the EU stress test:

1. SBO
2. loss of the ultimate heat sink
3. simultaneous occurrence of a SBO and a loss of the ultimate heat sink

The stress test considered both measures and procedures that are feasible and have been prepared/preplanned with plant-internal equipment and organisational structures as well as measures for which components or technical equipment have to be brought to the plant grounds.

In addition, the accident management measures provided in the emergency manual were reviewed. Specifically, emergency measures for core cooling, maintaining containment integrity and limiting the release of activity were examined. The analyses regarding the limitation of activity release also included examinations of the heat removal from the spent fuel pool and the possibility to refill the latter. Compared with the RSK-SÜ, the EU stress test has yielded no fundamentally new insights.

2.2 Activities performed by the operator

In its statement on the RSK-SÜ, the Reactor Safety Commission confirmed to the BMU that in the area of external hazards, "the effects to be considered according to the state of the art in science and technology in connection with occurrence frequencies of approx. 10^{-3}/a, especially those that may lead to "cliff edge" effects, are taken into account throughout in the designs of German nuclear power plants" and that "the electricity supply of the German nuclear power plants is more robust throughout than at Fukushima I."

In their safety reviews the German operators came to the conclusion that beyond-design-basis events due to natural hazards can practically be excluded in their NPPs. With the 12th amendment of the Atomic Energy Act (AtG), the legislator has established by law a duty of care in § 7d AtG according to which the operators are required to put into effect safety provisions that are correspondingly developed, suitable and appropriate for making a not merely slight contribution to further precaution against risks for the general public. It was against this background, too, that the operators assessed the recommendations of the RSK-SÜ and derived corresponding measures.

Due to the high degree of robustness of the German plants not only in the design but also in the beyond-design-basis range and thanks to the balance of the defence-in-depth concept, further room for improvement is seen essentially in the area of accident management measures. Should any plant improvements ensue, these will be carefully specified with regard to their concepts and technical as well as organisational aspects and will subsequently be implemented. Against this background it is also necessary to transfer the direct plant-specific measures that were taken immediately after the events at Fukushima and which are described in the following sections into an integrated overall concept, if needed in an adapted form.

The general objective at present is therefore the extension of the plant-specific accident management concepts as part of a sustainable integrated overall concept with the aim to increase the robustness of the plants, i.e. the already existing safety margins, beyond the design basis.

The measures include amongst other things a concept for the extended availability of the assured direct-current (DC) power supply as well as of the battery support by additional emergency power generators, a concept for a further improvement of the management of lubricants and operating materials for the supply of diesel fuel in the event of a sustained loss of offsite power, verifications of the assured cooling of the spent fuel pool via evaporation cooling, additional emergency measures for external coolant injection into the spent fuel pool, if necessary by means of additional equipment, and the preparation of Severe Accident Management Guidelines (SAMG). The study of the evaporation cooling and integrity of the spent fuel pool under boiling conditions, which is necessary in connection with spent fuel pool injection, is now available, as part of an integrated concept to increase robustness against a station blackout (SBO) and long-lasting loss of offsite power by means of mobile emergency power generators. An adaptation of these concepts and perhaps further measures may have to be provided depending on the insights that may yet be gained from the ongoing follow-up analyses of the Fukushima accident.

2.2.1 A short discussion or overview of the actions taken or planned by the nuclear power plant (NPP) operator to address the topic

Loss of electricity supply

Note: Owing to the high relevance of the electrical energy supply, a multiply staggered concept has been realised in German plants to ensure three-phase current supply, going beyond the requirements of the applicable regulations as well as what is common and has been realised in many foreign plants and thereby provides a comparably high level of robustness. Internationally (e.g. by the IAEA or in the US), a SBO is defined as a loss of the auxiliary power supply as well as the existing emergency power supply installations. The postulate of a loss of a further diverse emergency power supply installation (emergency diesels supplying among else the emergency feedwater system as realised in the German plants) goes beyond this definition.

From the point of view of the operators, sufficient margins exist to control a loss of the electricity supply owing to the required high degree of robustness of the systems. Hence in the opinion of the operators there is no need for a change to existing installations or plant components. In the same way, no additional precautionary measures are provided.

The aim of a further increase of the level of robustness would therefore be to ensure the vital functions of the plant for the postulated event involving the loss of the existing stationary diverse emergency power supply options as well as in an unexpectedly long-lasting loss of offsite power.

For the remaining NPPs in power operation, additional power generators are to be provided. It has to be possible to use these in the event of the failure of the complete three-phase current supply and with consideration of unfavourable ambient conditions such as flooding, debris or aggravating radiological conditions. The additional power generators have to be protected against external loads such as an earthquake and flooding in such a way that they are kept outside the impact range of such events (e.g. physical separation). These generators have to be ready for feeding before the DC current supply batteries are fully discharged or otherwise at the moment when any necessary emergency measures for residual-heat removal – provided these require a supply of electricity – need to be put into effect. Their arrangement in case of a challenge is such that distances to the connecting points for fuel and electricity are sufficiently short. The power generators are to be designed according to relevant VDE standards for all plants (VDE: Association for Electrical, Electronic & Information Technologies).

In assessing the period until the generators' readiness to feed and their operability, fuel supply is explicitly taken into consideration. It is possible e.g. to obtain the fuel from diesel storage tanks. Further fuel supplies from centralised storages or supplementary deliveries are provided. The fuel stocks should be in such amounts that together with the specified discharge time of the battery system, it is possible to bridge ten hours.

After the Fukushima accident, direct action was taken for some plants. For example, the following immediate measures to increase robustness were provided or implemented in some individual plants:

- obtaining mobile emergency power generators and/or contractual agreements on the delivery of (further) generators if necessary,
- further improvement of an accident management measure for steam generator feeding from the emergency feedwater tank with mobile pumps as well as connec-tion of these pumps to a mobile diesel generator.

Loss of cooling

From the point of view of the operators, sufficient margins exist to control a loss of cooling owing to the required high degree of robustness of the systems. Hence in the opinion of the operators there is no need for a change to existing installations or plant components. In the same way, no additional precautionary measures are provided.

After the Fukushima accident, direct action was taken for some plants. For example, the following immediate measures to increase robustness were provided or implemented in some individual plants:

- obtaining additional emergency power generators for SBO as reinforcement of the power supply and hence to increase robustness in the event of a loss of the auxiliary service water system.

Containment integrity

From the point of view of the operators, sufficient margins exist to maintain containment integrity owing to the required high degree of robustness of the systems. Hence in the opinion of the operators there is currently no need for a change to existing installations or plant components. In the same way, no additional precautionary measures are provided.

Failure of spent fuel pool cooling

From the point of view of the operators, sufficient margins exist to control a failure of spent fuel cooling owing to the required high degree of robustness of the systems. Hence in the opinion of the operators there is currently no need for a change to existing installations or plant components. In the same way, no additional precautionary measures are provided.

Nevertheless, the integrity of the spent fuel pool under boiling conditions is to be dem-onstrated under best-estimate assumptions. Boundary conditions for the assessment had been drawn up by the end of the first quarter of 2012. As regards the heat removal from the spent fuel pool, evaporative cooling is included in the accident management concept. Moreover, plant-specific options are created for making up the coolant of the spent fuel pool by means of mobile pumps without the need to enter the pool area.

After the Fukushima accident, direct action was taken for some plants. For example, the following immediate measures to increase robustness were provided or implemented in some individual plants:

- measure for coolant injection into the spent fuel pool by means of mobile equipment (e.g. from fire-extinguishing or demineralised-water system) and development of corresponding emergency procedures or shift instructions, and exercising of the measure.

2.2.2 Schedules and milestones to complete the operator's planned activities

The implementation of the planned activities will takes place within the framework of the nuclear licensing and supervisory procedure.

Statements on the Information Notice (WLN) prepared and issued by GRS on the conclusions drawn from the Fukushima accident are made to the competent supervisory authorities; individual aspects were adopted into the operators' working programmes in order to prepare an integrated concept for the extension of the plant-specific accident management concepts. Moreover, issues from the peer review process in connection with the EU stress test as well as individual aspects from the national reports of other countries are currently being assessed by all operators, both generically and plant-specifically.

2.2.3 Preliminary or final results of these activities, including proposals for further actions

Once the integrated overall concept, including the already implemented immediate measures, has been presented and subsequently put into practice, the safety gain will be assessed plant by plant. The implementation of the overall concept will be done plant-specifically within the framework of the licensing and supervisory procedure, taking the results of the consultations within the RSK into account.

2.3 Activities performed by the regulator

2.3.1 A short discussion or overview of the actions taken or planned by the regulatory body to address the topic

BMU

The BMU has awarded the research project "Safety and risk issues following up the nuclear events and accidents in Japan, Phase 1".

On behalf of the BMU, GRS prepared an Information Notice on the conclusions drawn from the studies carried out into the Fukushima accident for German NPPs.

Based on continuously on-going analysis by Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) and the recommendations of the RSK-SÜ, GRS prepared a so-called Information Notice. In it, 22 specific recommendations were derived for enhancing the safety of German NPPs.

These comprise above all technical measures against beyond-design-basis events, including in particular measures relating to:

- electrical energy supply
- coolant supply
- further aspects of accident management
- fire protection
- seismic design

RSK

Based on the results of the RSK safety review of the German NPPs against the background of the events at Fukushima Daiichi (Japan), the RSK is planning to perform more detailed analyses on the following aspects:

- station blackout
- loss of offsite power supply
- loss of auxiliary service water supply
- preventive measures
- general issues.

KTA

The KTA subcommittee on "Programme and Fundamental Issues" and the KTA Steering Committee have discussed the need for amending several KTA Safety standards against the background of the events at Fukushima. As regards "Design issues", the following Safety Standards were identified as requiring further discussion:

- KTA 2103 "Explosion Protection in Nuclear Power Plants with Light Water Reactors (General and Case-Specific Requirements)"
- KTA 3301 "Residual Heat Removal Systems for Light Water Reactors"
- KTA 3303 "Heat Removal Systems for Fuel Assembly Storage Pools in Nuclear Power Plants with Light Water Reactors"
- KTA 3701 "General Requirements for the Electrical Power Supply in Nuclear Power Plants"
- KTA 3702 "Emergency Power Generating Facilities with Diesel-Generator Units in Nuclear Power Plants"
- KTA 3703 "Emergency Power Facilities with AC/DC Converters in Nuclear Power Plants"
- KTA 3704 "Emergency Power Facilities with DC/AC Converters in Nuclear Power Plants"
- KTA 3705 "Switchgear Facilities, Transformers and Distribution Networks for the Electrical Power Supply of the Safety System in Nuclear Power Plants"
- KTA 3706 "Ensuring the Loss-of-Coolant-Accident Resistance of Electrotechnical Components and of Components in the Instrumentation and Controls of Operating Nuclear Power Plants"

EU stress test

The regulatory authorities are currently reviewing various different measures to enhance the safety of the German NPPs on the basis of the findings of the EU stress test.

Tasked by the BMU, the RSK will take the results of the EU stress test into account in its further discussions.

Information Notice (WLN)

GRS was commissioned by the BMU to prepare an Information Notice. This information Notice included the following recommendations:

On electric power supply:

1. In case of a station blackout[1], it has to be ensured that the plant can be kept in a stable subcritical state, and the residual heat can be removed safely for at least 10 hours by all means and personnel available at the plant. The power supply required for this (e.g. batteries) as well as the power supply of the accident measuring systems and the necessary lighting have to be ensured.

2. In case of a station blackout, accident management measures have to be provided by which, with an additional emergency power generator, the three-phase supply can be re-established within 10 hours. The emergency power generator has to be capable of supplying all systems that are required for plant shutdown and heat re-moval from the reactor core and the fuel pool. If additional operating agents and auxiliary equipment are required,

1 Loss of the entire non-battery-buffered electric AC voltage supply, i.e. loss of the station power supply and loss of all emergency diesel generators and of all additional emergency diesel generators.

their availability has also to be ensured. For connection of the emergency power generator, there have to be two physically separated feed points, such that preferably one of these points will still be available in case of a beyond-design-basis hazard. The emergency power generator, too, has to be available in case of a beyond-design-basis hazard[2], especially in case of earthquakes, flooding and damage to plant-internal and external infrastructure. The operating fluids supply to the emergency power generator and to all essential systems has to be accordingly ensured, and all required tools and connection cables have to be kept ready.

On coolant supply:

1. A service water supply, independent regarding its power supply and the required auxiliary systems, has to be available at the site. This has to be independent of the cooling water intake available by design, and both the residual-heat and the waste heat of required systems (e.g. diesels) have to be removed by it in the long-term. Its availability in case of design-basis natural hazards has to be ensured.

2. As emergency measure, a pump designed against beyond-design-basis events, which commensurate with its task is mobile and independent of the power supply of the plant, has to be provided. For the connection of this pump, two physically sufficiently separated connecting nozzles at different redundancies of the secured component cooling system have to be available. The latter have to be usable for core cooling including fuel pool cooling.

3. For PWR plants, there should be a possibility of a reactor pressure vessel injection with borated water that is independent of the active emergency cooling system, taking account of the existing safety-related design. Here, special attention has to be paid to ensure that no interactions take place.

2.3.2 Schedule and milestones to complete the regulatory body's planned activities

Activities planned for the year 2012:

- Continuation of the RSK working programme with the following focal issued

  – loss of offsite power
  – station blackout
  – loss of auxiliary service water
  – AM measures

- Research project "Safety and risk issues following up the nuclear events and accidents in Japan, Phase 1"

- Preparation of an Information Notice on the conclusions drawn from the studies carried out into the Fukushima accident for German NPPs by GRS for the BMU

- Consideration of the lessons learned from Fukushima in the new nuclear regulations "Safety Requirements for Nuclear Power Plants"

- Consideration of the lessons learned from Fukushima in the so-called "backfitting list" (list of safety-related requirements/measures for further risk prevention)

- Schedule and progress of the reviews carried out by the KTA and the preparation of first draft Safety Standards

2.3.3 Preliminary or final results of these activities, including proposals for further actions

The first recommendations of the RSK and the Information Notice have established the boundary conditions for the implementation of first improvement measures on the part of the operators. Follow-up statements by the RSK are planned to be issued by the autumn of 2012. The BMU will coordinate the implementation of the necessary measures with the nuclear supervisory authorities of the federal Länder.

2 These beyond-design-basis hazards have to be determined site-specifically.

2.4 Synoptic table of the activities described in 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2 and 2.3.3

	Activities performed by the operator			Activities performed by the regulator		
Activities	(Section 2.2.1) Activities • performed? • ongoing? • planned?	(Section 2.2.2) Schedules or milestones to complete the planned activities	(Section 2.2.3) Available results • Yes? • No?	(Section 2.3.1) Activities • performed? • ongoing? • planned?	(Section 2.3.2) Schedules or milestones to complete the planned activities	(Section 2.3.3) Available conclusions • Yes? • No?
Topic 2 – Design Issues						
Extended availability of the assured direct-current (DC) power supply as well as of the battery support by additional emergency power generators as part of an integrated overall concept	ongoing		no			
Further improvement of the management of lubricants and operating materials for the supply of diesel fuel in the event of a sustained loss of offsite power as part of an integrated overall concept	ongoing		no			
Verifications of the assured cooling of the spent fuel pool via evaporation cooling as part of an integrated overall concept	ongoing		no			

	Activities performed by the operator			Activities performed by the regulator		
Activities	(Section 2.2.1) Activities • performed? • ongoing? • planned?	(Section 2.2.2) Schedules or milestones to complete the planned activities	(Section 2.2.3) Available results • Yes? • No?	(Section 2.3.1) Activities • performed? • ongoing? • planned?	(Section 2.3.2) Schedules or milestones to complete the planned activities	(Section 2.3.3) Available conclusions • Yes? • No?
Topic 2 – Design Issues						
Additional emergency measures for external coolant injection into the spent fuel pool, if needed with additional equipment, as part of an integrated overall concept	ongoing		no			
Preparation of Severe Accident Management Guidelines (SAMG) as part of an integrated overall concept	ongoing		no			
Obtaining mobile emergency power generators and/or contractual assurance of the provision of (further) generators on demand	performed		yes			
Further improvement of an accident management measure for steam generator feeding from the emergency feedwater pool with mobile pumps as well as connection of these pumps to a mobile diesel generator	performed		yes			

Topic 2 – Design Issues						
Obtaining additional emergency power generators for SBO as reinforcement of the power supply and hence to increase robustness in the event of a loss of the auxiliary service water system	performed		yes			
Measure for coolant injection into the spent-fuel pool via mobile equipment (e.g. fire extinguishing system or demineralisedwater system) and development of corresponding emergency procedures or shift instructions, and performance of emergency exercises of the measure.	performed		yes			
Operators' responses to the Information Notice (WLN) on Fukushima	planned		no			
Preparation and release of the Information Notice (WLN) on Fukushima				performed		no
Research project "Safety and Risk Issues"				ongoing	30/06/2012	no
New regulations (Safety Requirements for Nuclear Power Plants)				ongoing	3rd quarter of 2012	no
RSK examinations				planned	autumn 2012	no
KTA Safety Standards				ongoing	from November 2012	no

3 TOPIC 3 – SEVERE ACCIDENT MANAGEMENT AND RECOVERY (ON SITE)

On-site emergency planning is a duty of the operator of a nuclear installation. According to the protection provisions of the Atomic Energy Act [1A-3] und Section 51 of the Radiation Protection Ordinance [1A-8], the operator is responsible – within the frame-work of on-site emergency planning – to keep the risk of potential hazards for man and the environment as low as possible in case of incidents and accidents. The measures of the operator are divided into preventive and mitigative measures. Main objective of the preventive measures is to reach and maintain a plant condition which prevents severe core damages. The mitigative measures serve for limiting consequences.

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

Emergency plans and alerts

The alarm regulation of the nuclear power plant includes regulations on alerting of internal and external parties if defined threshold criteria are exceeded. It is part of the operating manual and belongs to the safety specifications. For coping with emergencies, the plant operator establishes a crisis management organisation with a crisis management team. Emergency exercises are taking place regularly, at least once a year; several times a year individual exercises like alarm procedures or individual emergency measures for training of the personnel involved, for testing of the function of the equipment and for checking of expediency and effectiveness of all pre-determined administrative measures are taking place. The individual organisational regulations are described in a separate document, the accident management manual.

The Nuclear Safety Standards Commission (KTA) prepared specifications on the con-tent and design of the accident management manual which are compiled in the draft safety standard [KTA 1203].
In their entirety, the alarm regulation and the operating manual represent the emergency plan of the plant operator, which includes, among others:

- measures to make emergency organisation operable,
- criteria for alerting the responsible authorities,
- technical measures for prevention and mitigation of damages,
- measurement programmes for determining the radiological situation, and
- measures for efficient communication and co-operation with external parties, such as the responsible authority, and for informing the public.

Assistance for the crisis management organisation is provided by the crisis management team of the plant manufacturer and by the Kerntechnischer Hilfsdienst GmbH (a permanent organisation jointly installed by the operators of German nuclear power plants). The crisis management team of the manufacturer advises the plant operator in technical questions of situation assessment and restoration of safe plant condition, while the Kerntechnischer Hilfsdienst with its manipulators and measurement equipment may be employed at the site, inside and outside the plant. In addition, contractual agreements exist between the plant operators on mutual support.

On-site measures

The operator of a nuclear power plant is responsible for the performance of all on-site measures for coping with emergencies. Preventive measures, to prevent severe core damages and mitigative measures, to limit consequences are provided in all plants and are described in the emergency manual. The implementation of these measures required comprehensive backfitting measures (see Tab. 3-1).

Exercises

Training

In order to be able to perform the measures required in the case of an event effectively, the persons involved in coping with the crisis have to be properly qualified and trained. Therefore, great importance is attached to on-site and off-site training of task personnel. This is specified in the regulatory guidelines on technical qualification [3-2] and applies, in particular, to the preparation of the plant personnel and especially of the responsible shift personnel for coping with an emergency at the plant.

For external task personnel (authorities), qualification and training are performed task-specifically in the respective organisations.

Exercises of the plant operator

The measures provided by the plant operator are trained, checked and further developed by means of exercises performed at regular intervals. Exercises involving the emergency organisation of the plant operator are generally performed by the operating organisations once a year per NPP unit according to the RSK statement “Allgemeine Anforderungen an Krisenstabsübungen” on general requirements for crisis management team exercises of 18.03.1992 (268th meeting).

In order to be able to perform exercises as close to reality as possible, the accident scenarios on which the exercises are based are prepared generally in very detail. Typical exercise scenarios are beyond design events with loss of coolant, external events (earthquake, flood, aircraft crash, etc.), anticipated transients without scram (ATWS) and station blackout. In order to simulate beyond design situations according to the objectives of the respective exercise, these events are combined with inadequate core cooling and/or residual heat removal and/or inadequate containment isolation. As before, events in the field of physical protection are included in the exercise programme of the plant operators. In detail, the exercises aim at, e.g.: internal and external alerting, application and, at the same time, review of the practicability of the written operating procedures and, as far as possible, of the technical provisions, detection and actuation of alarms (early warning, emergency alert); documentation of the processes, measuring campaigns, rescue of persons from radiation-controlled areas, build-up of decontamination facilities; organisational and work procedures of the crisis management team and public relations.

The exercises are performed at the plants as realistic as possible, making increasingly use of the nuclear power plant simulators.

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

As a matter of principle, the authorities are informed about on-site exercises and often participate as observers on the ground. The number of exercises in which the technical departments of the site and the authorities practice their cooperation and communication is increasing. This cooperation is complemented by supervisory visits and the performance of, for

example, on-site activities by the authority that are supervisory priorities. On the part of the operators, exercises are introduced and discussed within the scope of the exchange of experiences and feedback, e.g. in VGB Working Panels. Exercises of other plants are also observed across locations and sites.

In addition to exercises performed under participation of the supervisory authority and the authorised expert, also internal exercises on accident management including the interfaces to disaster control are carried out.

Among other things, exercises

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

were carried out.

These exercises partially took place at a simulator also including the crisis centre and the remote monitoring system for nuclear reactors of the respective Land. Exercise reports are prepared on the course of the on-site and essential findings exer-cises and identified improvements are included in the emergency preparedness planning. During training measures, the staff receives a feedback. The documentation on the accident management is regularly reviewed with regard to completeness and correctness (e.g. alert lists).

The exercises on accident management and disaster control showed that the provided measures meet the requirements.

The activities performed by the German operators regarding the implementation of the Severe Accident Management Program (SAMP) for coping with beyond design basis and severe accidents have been carried out on the basis of the recommendations made by the RSK in this regard since the late 80s.

In the context of the Safety Reviews required by the § 19a of the Atomic Energy Act, the licence holders shall report on all on-site emergency control measures. The Guides for the Safety Review of Nuclear Power Plants define some beyond design scenarios to be analysed and covered by the accident management manual.

In PWR, the fuel pool is located within the containment. Due to the containment isola-tion triggered by the reactor protection, the containment leaktightness is ensured reliably. Beyond design pressure build-up in the containment can be effectively prevented by intended emergency measure “containment venting”. The arising hydrogen concentrations are minimised by the passive autocatalytic recombiners at an early stage.

A comprehensive documentation of all implemented preventive and mitigative measures and especially of hardware changes carried out in all German nuclear power plants is provided in the reports of the Federal Government under the Convention on Nuclear Safety, e.g. in its latest report released in 2011 [CNS-08]. Table 3-1 shows the state of implementation of necessary accident management measures in BWR plants; Table 3-2 shows the state of implementation of necessary accident management measures in PWR plants.

Table 3-1: Implementation of accident management measures in BWR (4/2011)

Measure	KKB	KKI 1	KKP 1	KKK	KRB B	KRB C
Accident management manual	●	●/1991	●/1989	●/1988	●/1991	●/1991
Independent injection system	●	●	●/1991	●/1989	☐	☐
Additional injection and refilling of the reactor pressure vessel	●	●	●/1990	●/1988	●/1995	●/1995
Assured containment isolation	●/1988	●	●/1989	●/1988	✓	✓
Diverse pressure limitation for the reactor pressure vessel	●/1991	●/1990	●/1990	●/1991	●/1992	●/1993
Filtered containment venting	●/1988	●	●/1989	●/1988	●/1990	●/1990
Containment inertisation	●/1988	●	●/1988	●/1988	●*/1990	●*/1990
Supply-air filtering for the control room	●/1998	●	●/1989	●/1988	●/1990	●/1990
Emergency power supply from neighbouring plant	☐	☐	●/1984–1985	☐	●	●
Increased capacity of batteries	●	✓	●/1987–1988	●/1990	✓	✓
Restoration of external power supply	●	●	●	●/1989	●	●
Additional external power supply (underground cable)	●/1990	●	●/1992	●/1990	●/1991	●/1991
Containment sampling system	○	●/2007	●/2001	○	●/2009	●/2009

* wetwell inerted, equipped with passive catalytic recombiners (carried out 1999–2000)

✓ design ● realised through backfitting measures ○ applied for ☐ not applicable

In case of an event, there are clear criteria based on directly measurable physical values for the implementation of one of the integrated accident management measures. Basically, precise criteria are available for the shift supervisor as to when to follow the symptom-oriented instructions of the operating manual or the so called “accident management manual”. Alert criteria are defined to activate the Emergency Response Organisation respectively the Emergency Response Team, which will take over the responsibility/decision-making in case of a beyond design basis accident as soon as the team is operational.

In case of a disaster, external support can be requested. For this purpose, emergency response teams are formed at the respective parent company, if necessary with personnel from the surrounding plants, and at the manufacturer (AREVA). Additionally, the equipment and the personnel of the Kerntechnischer Hilfsdienst GmbH can be requested by the plant. Organisational, personnel and technical measures and provisions are reviewed in the exercises at least yearly. These exercises are based on accident scenarios which take due account of the plant behaviour in case of accidents.

In 2003, the development of higher-level rules and regulations requirements, among others, for accident management measures was started. The international rules and regulations of e.g. the IAEA [CNS-06, CNS-07] and WENRA [CNS-09] have been taken into account. Completion is targeted for the end of 2012.

Table 3-2: Implementation of accident management measures in PWR (4/2011)

Measure	KWB A	GKN I	KWB B	KKU	KKG	KWG	KKP 2	KBR	KKI 2	KKE	GKN II
Accident management manual	●/1990	●/1988	●/1990	●/1989	●/1993	●/1992	●/1990	●/1987	●/1991	●/1994	●/1988
Secondary-side bleed	●/2002	●/1992–94	●/2003	●/1992	●/1995	●/1993	●/1992	●	●/1995	✓	✓
Secondary-side feed	●/2002	●/1991	●/2003	●/1992	●/1990	●/1993	●/1992	●/1994	●/1995	●/1990	●/1991
Primary-side bleed	●/1990	●/1993	●/1991	●/1991	●/ 1999	●/1999	●/1993	●/2003	●/1995	●/1996	●/1993
Primary-side feed	●/1990	●/1993	●/1990	●/1991	●/1995	●/1999	✓	●/1999	●/1995	✓	✓
Assured containment isolation	●/1991	●/1990	●/1991	●/1991	●/1991	✓	●/1990	●	●	✓	✓
Filtered containment venting	●/2002	●/1992	●/2003	●/1992	●/1993	●/1993	●/1990	●/2003	●/1991	●/1991	●/1990
Catalytic recombiners to limit hydrogen generation	●/2010	●/2001	●/2003	●/2000	●/2000	●/2000	●/2001	●/2003	●/2000	●/1999	●/1999
Supply-air filtering for the control room	●/1989	●/1991	●/1989	●/1989	●/1992	●/1990	●/1990	●/1998	●/1989	✓	●/1988
Emergency power supply from neighbouring plant	●	●/1990	●/	☐	☐	☐	●/1984	☐	☐	☐	●/1988
Sufficient capacity of batteries	●/1991–92	●/1989–93	●/1991	✓	●/1995	✓	●/2001	●	●/1989	●/1988–90	●/1988
Restoration of external power supply	●/1990	●/1989	●/1990	●/1989	●/1990	●/1990	●/1989	●/1995	●	●/1996	✓
Additional external power supply (underground cable)	●/1985	●/1989	●/1985	●/1992	●/1995	●/1993	●/1992	●/1995	●/1992	●/1993	●/1988
Containment sampling system	○	●/1999	●	●/2001	●/2003	●/2000	●/2001	●/2007	●/2002	●/2000	●/2002

✓ design ● realised through backfitting measures ○ applied for ☐ not applicable

3.1 A short discussion or overview of the topic analysis performed by the Contracting Party

RSK Safety Review

In the RSK safety review (RSK-SÜ), the necessary wide scope of the accident management measures and their efficiency were analysed. It was to determine to what extent the effectiveness of the available accident management measures, also under farther reaching assumptions, can lead to aggravating boundary conditions due to external events or postulates, and to what extent additional accident management measures for a further minimisation of the residual risk might be useful. For this purpose, questionnaires have been submitted to the operators. Based on the first oversight, RSK emphasised that the answers supplied to the questionnaire are presently not sufficient to allow a consistent allocation to plant-specific accident management measures to different levels of robustness according to the defined criteria. With respect to the events at Fukushima, following the evaluation of the answers and other information provided, the RSK has therefore derived generic key aspects for further considerations.

EU Stress test

In the frame of the EU stress test, the measures in case of a severe accident were examined. In their reports, the operators had to deliver a description of measures for different accident scenarios.

3.2 Activities performed by the operator

In its statement on the RSK-SÜ, the Reactor Safety Commission confirmed to the BMU that in the area of external hazards, "the effects to be considered according to the state of the art in science and technology in connection with occurrence frequencies of approx. 10^{-3}/a, especially those that may lead to "cliff edge" effects, are taken into account throughout in the designs of German nuclear power plants" and that "the electricity supply of the German nuclear power plants is more robust throughout than at Fukushima I."

In their safety reviews the German operators came to the conclusion that beyond-design-basis events due to natural hazards can practically be excluded in their NPPs. With the 12th amendment of the Atomic Energy Act (AtG), the legislator has established by law a duty of care in § 7d AtG according to which the operators are required to put into effect safety provisions that are correspondingly developed, suitable and appropriate for making a not merely slight contribution to further precaution against risks for the general public. It was against this background, too, that the operators assessed the recommendations of the RSK-SÜ and derived corresponding measures.

Due to the high degree of robustness of the German plants not only in the design but also in the beyond-design-basis range and thanks to the balanced defence-in-depth concept, further room for improvement is seen essentially in the area of accident management measures. Should any plant improvements ensue, these will be carefully specified with regard to their concepts and technical as well as organisational aspects and will subsequently be implemented. Against this background it is also necessary to transfer the direct plant-specific measures that were taken immediately after the events at Fukushima and which are described in the following sections into an integrated overall concept, if needed in an adapted form.

The general objective at present is therefore the extension of the plant-specific accident management concepts as part of a sustainable integrated overall concept with the aim to increase the robustness of the plants, i.e. the already existing safety margins, beyond the design basis.

The measures include amongst other things a concept for the extended availability of the assured direct-current (DC) power supply as well as of the battery support by additional emergency power generators, a concept for a further improvement of the management of lubricants and operating materials for the supply of diesel fuel in the event of a sustained loss of offsite power, verifications of the assured cooling of the spent fuel pool via evaporation cooling, additional emergency measures for external coolant injection into the spent fuel pool, if necessary by means of additional equipment, and the preparation of Severe Accident Management Guidelines (SAMG). The study of the evaporation cooling and integrity of the spent fuel pool under boiling

conditions, which is necessary in connection with spent fuel pool injection, is now available, as part of an integrated concept to increase robustness against a station blackout (SBO) and long-lasting loss of off-site power by means of mobile emergency power generators. An adaptation of these concepts and perhaps further measures may have to be provided depending on the insights that may yet be gained from the ongoing follow-up analyses of the Fukushima accident.

3.2.1 A short discussion or overview of the actions taken or planned by the nuclear power plant (NPP) operator to address the topic

Since the systems to control and mitigate severe accidents have already been implemented in the German NPPs and the corresponding procedures are in place, no further measures for this purpose are intended at the moment. However, the accident management programs are being constantly assessed against the background of the latest knowledge and experience obtained from different international sources. The development and implementation of SAMG has been announced.

The development of the manual for mitigative Severe Accident Management Measures (SAMG) in GKN I can be seen as a model for all PWR plants. Generic SAMG for all PWR are currently developed on the basis of the GKN I manual and are expected to be completed in 2012. Subsequently, there will be the plant-specific adaptation of the generic template to the remaining plants. The accident management measures are analysed for their functionality and feasibility regarding external events. Necessary technical equipment and auxiliary means and supplies are positioned beyond the sphere of influence of external events.

After the Fukushima accident, some plants responded immediately by taking direct action. For example, the following immediate measures were planned or realised at some plants to increase robustness. All measures provided for the accident management extension were already described in the Sections 1.2.1 and 2.2.1 “Activities performed by the operator”.

3.2.2 Schedules and milestones to complete the operator’s planned activities

The generic SAMG for PWR are expected to be completed in 2012; then first plant-specific SAMG will be developed.

Statements on the Information Notice (WLN) prepared and issued by GRS on the conclusions drawn from the Fukushima accident are made to the competent supervisory authorities; individual aspects were adopted into the operators’ working programmes in order to prepare an integrated concept for the extension of the plant-specific accident management concepts. Moreover, issues from the peer review process in connection with the EU stress test as well as individual aspects from the national reports of other countries are currently being assessed by all operators, both generically and plant-specifically.

3.2.3 Preliminary or final results of these activities, including proposals for further actions

Once the integrated overall concept with consideration of the already implemented immediate measures and the subsequent actions taken is available, the safety gain for each plant will be assessed. The implementation of the overall concept will be done plant-specifically within the framework of the licensing and supervisory procedure, taking the results of the consultations within the RSK into account.

3.3 Activities performed by the regulator

The main RSK recommendations regarding the German “Severe Accident Management Program” were published in 1992 [CNS-03] or 1997 [CNS-04] and describe the general requirements for the implementation of the accident management measures on the basis of additional hardware for accidents during power operation. In 2009/2010, the German RSK started a new discussion concerning the accident management measures implemented in Germany. This resulted in a publication of new and extended recommendations entitled “Rahmenempfehlungen für die Planung von Notfallschutzmaßnahmen durch Betreiber von Kernkraftwerken“ (Basic recommendations for the planning of Emergency Management Measures by the Licensees of Nuclear Power Plants) [CNS-05].

The new “Safety Requirements for Nuclear Power Plants”, currently under development, include requirements for beyond design basis plant conditions.

3.3.1 A short discussion or overview of the actions taken or planned by the regulatory body to address the topic

RSK

Based on the results of the RSK safety review of the German NPPs and against the background of the events at Fukushima Daiichi (Japan), the RSK plans to carry out more detailed analyses of individual aspects of the topic areas earthquake and flooding.

The accident management concept should be further developed such that the effectiveness of the accident management measures in case of external events is ensured. Here, the following aspects regarding external events must be taken into consideration:

- restrictions of accessibility of the plant site and of the plant,
- functionality of the accident management measures,
- availability of an alternative on- or off-site technical support centre.

The availability of three-phase current is a necessary prerequisite for the vast majority of the accident management measures which ensure or restore the vital functions. Against this background, the concept has to be further developed such that in case of a postulated SBO a three-phase supply can be re-established within a plant specific grace time. From RSK’s point of view, these include:

- Standardised feed points protected against external hazards for the emergency power bus bar supply and if necessary for the emergency power bus bar supplying the emergency feedwater system,
- Keeping available of mobile emergency power generators protected against external hazards for the redundant residual heat removal or for recharging batteries.

Review of the accident management concept regarding the injection possibilities for fuel assemblies cooling and for ensuring subcriticality. Here, the following aspects regarding external events must be taken into consideration:

- Availability of mobile pumps and other injection equipment (hoses, connections, couplings etc.) protected against external hazards as well as of boron under consideration of the gracetime for preparation and delivery.
- Ensuring of water extracting points protected against external hazards and independent from the receiving water (if necessary, spatially separated).
- Water injection possibilities into the steam generator, the reactor pressure vessel and the containment (taking into consideration the higher back pressure) without the necessity of entering the area with a high risk potential (dose rate; debris) and to be able to compensate local destructions (by installed and spatially separated injection paths).

The still available safety margins in the beyond design basis range have to be identified on the basis of appropriate analyses and can be used, if necessary, with the procedures developed on this basis. This has to be taken into consideration in the context of the implementation, foreseen and currently in progress, of the so called Severe Accident Management Guidelines (SAMG).

Increased consideration of the wet storage of fuel assemblies in the accident management concept; here, the following aspects regarding external events must be taken into consideration:

- Water injection possibilities into the wet storage facility without the necessity of entering the area with a high risk potential (dose rate; debris) and to be able to compensate local destructions (e.g. by installed and spatially separated injection paths).

- For ensuring evaporation cooling: submitting of additional evidence for the fuel pool, reactor cavity, setdown pool, reactor cavity seal liner on boiling temperature.

- Measures for limitation of radioactive releases from the fuel pool in BWR with postulated severe fuel element damages, possibly with hydrogen formation.

EU Stress test

With respect to the RSK safety review, in the EU stress test no further results could be achieved.

Information notice (WLN)

GRS was commissioned by the BMU to prepare an Information Notice. This Information Notice contains the following recommendations with respect to the severe accident management:

1. The filtered containment venting is to be designed such that it can be operated under proposed boundary conditions in case of emergency situations, like e.g. station blackout with additional loss of direct-current supply, and also under unfavourable radiological conditions. Potential hydrogen combustion processes related to containment venting have to be excluded in venting lines and possibly in exhaust air collecting areas or in other containment building areas. Effective precautions have to be taken against direct impacts to a neighbouring unit e.g. by transmission of hydrogen or radionuclides via shared systems or lines. A long-term operating of the containment venting systems is to be provided. In case that the venting system is controlled remotely, erroneous initiations have to be reliably prevented. In case of exclusive manual actuation, accessibility has to be ensured.

2. In case that fuel elements are stored in the spent-fuel pool outside the containment, but inside the containment building, it has to be examined if a fortification of hydrogen is possible in this area. To prevent hydrogen accumulation, which can lead to formation of explosive gas mixtures, passive safety installations (e.g. catalytic recombiners) have to be available in this area to ensure their functionality also in cases of a station blackout lasting longer than 10 hours.

3. As an emergency measure, systems for fuel pool cooling have to be permanently installed, so that in case of demand, there is no need to enter endangered areas. Maloperations and erroneous tripping should be excluded.

4. For accident management measures, which have to be initiated from the control room, the possibility to initiate these from the remote shutdown station has to be provided. If necessary, functions in the remote shutdown station have to be extended and the necessary information for the initiation of these measures has to be made available.

3.3.2 Schedules and milestones to complete the regulatory body's planned activities

The RSK consultations are expected to be completed in 2012. Schedules for the implementation of further regulatory measures are not yet available.

3.3.3 Preliminary or final results of these activities, including proposals for further actions

The first recommendations of the RSK and the Information Notice have created the framework for the implementation of first improvement measures by the operators. Further RSK recommendations are planned by the autumn of 2012. The BMU will coordinate the implementation of the necessary measures with the nuclear regulatory authorities of the Länder.

3.4 Synoptic table of the activities described in 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2 and 3.3.3

	Activities performed by the operator			Activities performed by the regulator		
Activities	(Section 3.2.1) Activities • performed? • ongoing? • planned?	(Section 3.2.2) Schedules or milestones to complete the planned activities	(Section 3.2.3) Available results • Yes? • No?	(Section 3.3.1) Activities • performed? • ongoing? • planned?	(Section 3.3.2) Schedules or milestones to complete the planned activities	(Section 3.3.3) Available conclusions • Yes? • No?
Topic 3 – Severe Accident Management and Recovery (on Site)						
Extended availability of the assured directcurrent (DC) power supply as well as of the battery support by additional emergency power generators as part of an integrated overall concept	ongoing		no			
Further improvement of the management of lubricants and operating materials for the supply of diesel fuel in the event of a sustained loss of offsite power as part of an integrated overall concept	ongoing		no			
Verifications of the assured cooling of the spent fuel pool via evaporation cooling as part of an integrated overall concept	ongoing		no			

	Activities performed by the operator			Activities performed by the regulator		
Activities	(Section 3.2.1) Activities • performed? • ongoing? • planned?	(Section 3.2.2) Schedules or milestones to complete the planned activities	(Section 3.2.3) Available results • Yes? • No?	(Section 3.3.1) Activities • performed? • ongoing? • planned?	(Section 3.3.2) Schedules or milestones to complete the planned activities	(Section 3.3.3) Available conclusions • Yes? • No?
Topic 3 – Severe Accident Management and Recovery (on Site)						
Additional emergency measures for external coolant injection into the spent fuel pool, if needed with additional equipment, as part of an integrated overall concept	ongoing		no			
Implementation of SAMG	ongoing	2012 generic SAMG	no			
Obtaining mobile emergency power generators and/or contractual assurance of the provision of (further) generators on demand	performed		yes			
Improvement of the accessibility of the plant's sites during long-lasting flooding, e.g. by obtaining boats	performed		yes			

	Activities performed by the operator			Activities performed by the regulator		
Activities	(Section 3.2.1) Activities • performed? • ongoing? • planned?	(Section 3.2.2) Schedules or milestones to complete the planned activities	(Section 3.2.3) Available results • Yes? • No?	(Section 3.3.1) Activities • performed? • ongoing? • planned?	(Section 3.3.2) Schedules or milestones to complete the planned activities	(Section 3.3.3) Available conclusions • Yes? • No?
Topic 3 – Severe Accident Management and Recovery (on Site)						
Further improvement of an accident management measure for steam generator feeding from the emergency feedwater pool with mobile pumps as well as connection of these pumps to a mobile diesel generator	performed		yes			
Measure for coolant injection into the spent fuel pool, with mobile equipment (e.g. fire water system or demineralized water system) and development of corresponding emergency procedures or shift instructions and performance of emergency exercises of this measure	performed		yes			
Operator's responses to the Information No-tice (WLN) on Fukushima	planned		no			
RSK analyses				ongoing	autumn 2012	no
Preparation and release of Information Notice (WLN) on Fukushima				performed	no	no

4 TOPIC 4 – NATIONAL ORGANISATIONS

The Republic of Germany is a federal state. For the use of nuclear energy for peaceful purposes, the regulatory tasks are separated between the Federal Republic and the Länder. Here, the Federal Government has the exclusive legislative competence. The Atomic Energy Act and the statutory ordinances based thereon are executed to a great extent by the Länder on behalf of the Federation. In this respect, the Länder authorities are under the oversight of the Federation with regard to the legality and expediency of their actions.

The legality and expediency of the enforcement is supervised at the national level by the Directorate General RS "Safety of Nuclear Installations, Radiological Protection, Nuclear Fuel Cycle of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). The BMU is supported by the Federal Office for Radiation Protection (BfS) and consults the Commission on Radiological Protection (SSK), the Nuclear Waste Management Commission (ESK), and the Reactor Safety Commission (RSK) for advice. Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) advises BMU regarding in-depth technical issues. The expert organisations advice is provided in accordance with the current state of the art in science and technology. The state of the art in science and technology is continuously further developed by scientific institutions like universities, research institutions or research institutes and is also specified in the safety standards of the Nuclear Safety Standards Commission (KTA).

The organisational-structural separation of the licensing and supervisory functions of the state from the functions of other governmental institutions and organisations concerned with the use or promotion of nuclear energy is due to the organisation of state government. It has to be pointed out that there are different ministries at the national level, and different ministries or different and independent organisational units at the Länder level in charge of and responsible for different functions; in this respect, the competent nuclear and radiation protection regulations supervisory and licensing Länder authorities are under supervision of the federal executive administration regulations.

The Nuclear Safety Standards Commission (KTA) was established at the BMU/BfS. It is made up of the five interest groups: representatives of the manufacturers, the plant operators, the federal and Länder authorities, the expert organisations and representatives of general concerns, e.g. of the unions, the industrial safety and the liability insurers. KTA has the task to establish safety standards and to promote their application in fields of nuclear technology where experience and new developments indicate that the experts representing the manufacturers and operators of nuclear installations, the expert organisations and the federal and Länder authorities would reach a uniform opinion. The KTA safety standards are regularly adjusted to the state of the art in science and technology at intervals of no more than five years; due to implementation into the licensing procedure or due to supervisory radiation protection measures, they become binding for the specific installation. The regulatory powers of the legislator and administrative action by the competent authorities are not restricted by the KTA process. It is possible to formulate necessary requirements, guidelines and recommendations and to implement them on the basis of the Atomic Energy Act regardless of the consensual formulation of KTA safety standards. The competent authority for nuclear licensing of essential modifications of nuclear power plants or their operation is the supreme Land authority, usually the Environment Ministry of the respective federal state. These are also responsible for the supervision of nuclear installations in operation. In performing these tasks, the Land authority receives advisory support from experts, usually from the Technical Inspection Agencies (TUV). To fulfil certain functions the supreme Land authority is supported in some cases by subordinate authorities of the respective Land.

The Länder Committee for Nuclear Energy (LAA) serves for the coordination of Federal and Länder authorities in connection with the execution of the Atomic Energy Act as well as for the preparation of amendments and the further development of legal and administrative provisions as well as of the non-legally binding guidance instruments. LAA is a permanent Federation-Länder Committee composed of representatives from the Länder nuclear licensing and supervisory authorities and the BMU. In the interest of an execution of nuclear law that is as uniform throughout Germany as possible, the competent nuclear licensing and supervisory authorities of the Länder and the BMU draft any regulations on the uniform handling of nuclear law in consensus. These regulations are then promulgated by the BMU. The Committee's decisions are usually by mutual consent. For preparing decisions to be taken by the General Committee, the Länder Committee for Nuclear Energy avails itself of several Technical Committees as well as of the Working Groups assigned to these Technical Committees.

In relation to the above-mentioned state agencies, the licensees of the nuclear power plants – in their function as users and perhaps promoters of nuclear power – represent commercial enterprises under civil law. They are either power utilities themselves or are composed of shareholders from the ranks of the German power utilities. These power utilities are also commercial enterprises under civil law (usually joint-stock companies) and have no influence on the safety-directed actions of the licensing and supervisory authorities.

The regulations of the Atomic Energy Act on licensing and supervision are based on the principle of responsibility of the licensee. The modification licence is only granted if the applicant proves that the necessary technical and organisational precautions for a safe operation have been taken (fulfilment of the obligations of the licence holder according to the Atomic Energy Act). During operation, the plant operator has to fulfil his responsibility continuously.
German nuclear power plant operators are in regular contact with one another and exchange their experiences on safety related issues of NPPs at the national and international level; they also keep informed on the further development of the state of the art in science and technology in the field of ensuring nuclear safety.

The BMU pursues experiences gained from the operation of German and foreign nuclear power plants as well as the development of new safety solutions to derive important knowledge concerning the safety of German nuclear power plants in operation. Information notices inform on events from operation experience with a potential applicability to other plants. Nuclear power plant operator report on the consideration and implementation of the information notices to the authorities.

New findings on necessary precautions against risks and accident prevention are implemented into legal regulations and other provisions. Thus, the Atomic Energy Act was amended in December 2010. These amendments oblige the license holder to further develop the safety precautions and risk prevention for nuclear power plants in accordance with the progress in the state of the art in science and technology.

Furthermore, already existing duties of the plant operators regarding

- establishment and application of a management system giving due priority to nuclear safety,
- the adequacy of the financial means and human resources available,
- sufficient training and further qualification measures of the personnel in the field of nuclear safety

are explicitly laid down or have now been included into the Atom Energy Act.

In the event of serious accidents with radiological effects outside the nuclear power plant site, further regulatory bodies and other institutions become active, these are described in the Topic 6.

4.1 A short discussion or overview of the topic analysis performed by the Contracting Party

With the competent national organisations, Germany responded to the accident at the Fukushima nuclear power plant immediately and made short term decisions to evaluate the risk situation and to ensure safety of the German population as well as of the German nuclear power plants. In the light of these events, the Federal Government and the Minister Presidents of the Länder called upon the Reactor Safety Commission (RSK) in close cooperation with the competent nuclear supervisory authorities of the Länder to conduct a review of the German nuclear power plants' safety regarding their robustness against external events and against loss of safety functions, and decided a three-month suspension of operation of the seven oldest reactors and the NPP Krümmel. In the frame of European partnerships an EU stress test has been carried out. In addition to this safety review, BMU and RSK initiated an extensive investigation programme to draw the necessary conclusions from the Fukushima accident for the safe residual operating life of German plants until the year 2022. Further important insights have already become valid due to the amendment of the Atomic Energy Act in December 2010.

Furthermore, the Federal Government decided on the termination of the use of nuclear power for the commercial generation of electricity at the earliest possible date, staggered until 2022; the granting of further electricity production rights according to the amendment of the Atomic Energy Act was cancelled. During the investigation of the German regulatory system in the frame of the IRRS (Integrated Regulatory Review Service) follow-up mission in September 2011, the newly drew up IAEO Fukushimamodule has been applied to ascertain the lessons learned from the Fukushima accident for the German supervisory procedure. No fundamental deficiencies have been identified by the international experts.

The German legislative and regulatory system for ensuring the nuclear power plants' safety has a hierarchical structure, is historically grown, well established, has clear regulations on competencies, fulfils all international requirements and has proven successful from its inception and in the course of the revisions. This is also the case for the organisations involved.

The measures have shown that the national organisation system having responsibilities relating to the nuclear safety and the radiation protection is efficient, thus, there is no need to change this system.

4.2 Activities performed by the operator

4.2.1 A short discussion or overview of the actions taken or planned by the nuclear power plant (NPP) operator to address the topic

Currently, no measures are planned.

4.2.2 Schedules and milestones to complete the operator's planned activities

Currently, no measures are planned.

4.2.3 Preliminary or final results of these activities, including proposals for further actions

Currently, no measures are planned.

4.3 Activities performed by the regulator:

4.3.1 A short discussion or overview of the actions taken or planned by the regulatory body to address the topic

No measures for changing the structure or responsibilities of governmental institutions are planned.

The German system of the national organisation involved into the process of ensuring of nuclear power plant safety and the allocation of responsibilities has proved effective in assessing the effects of the Fukushima accident on Germany, also in determining measures for the protection of the population and in ensuring the safety of the German nuclear power plants.

The results and the conclusions from the IRRS follow-up mission show, that no acute weaknesses were pointed out [CNS-01]. No further recommendations were made. The IRRS team only makes recommendations regarding the improvement of the management systems by the BMU and a greater integration of the lessons learned from the Fukushima accident [CNS-02].

4.3.2 Schedules and milestones to complete the regulatory body's planned activities

Currently, no measures are planned.

4.3.3 Preliminary or final results of these activities, including proposals for further actions

Currently, no measures are planned.

4.4 Synoptic table of the activities described in 4.2.1, 4.2.2, 4.2.3, 4.3.1, 4.3.2 and 4.3.3

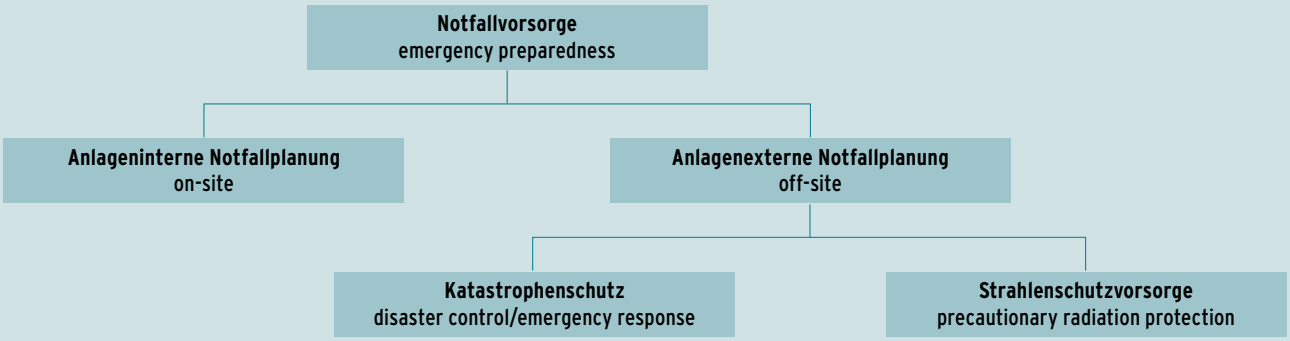
	Activities performed by the operator			Activities performed by the regulator		
Activities	(Section 4.2.1) Activities • performed? • ongoing? • planned?	(Section 4.2.2) Schedules or milestones to complete the planned activities	(Section 4.2.3) Available results • Yes? • No?	(Section 4.3.1) Activities • performed? • ongoing? • planned?	(Section 4.3.2) Schedules or milestones to complete the planned activities	(Section 4.3.3) Available conclusions • Yes? • No?
Topic 4 – National organisations						
No measures planned						

5 TOPIC 5 – EMERGENCY PREPAREDNESS AND RESPONSE AND POST-ACCIDENT MANAGEMENT (OFF SITE)

Structure and objectives of emergency preparedness

Nuclear emergency preparedness comprises on-site and off-site planning and preparedness for emergencies (→ Figure 5-1).

Figure 5-1 Structure of emergency preparedness



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

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

Tasks and competencies

On-site emergency planning is a duty of the operator of nuclear installation. Off-site emergency planning falls within the competence of the authorities of the Länder and the Federation (→ Figure 5-2).

Operator of the nuclear installation

According to the protection provisions of the Atomic Energy Act (AtG) [1A-3] and Section 51 of the Radiation Protection Ordinance [1A-8], the operator is responsible – within the framework of on-site emergency planning – to keep the risk of potential haz-ards for man and the environment as low as possible in case of incidents and accidents. The measures of the operator are divided into preventive and mitigative measures. Main objective of the preventive measures is to reach and maintain a plant condition which cannot lead to dangerous consequences. The mitigative measures serve for limiting consequences. The emergency plans of the operator shall ensure that these measures can be taken without any undue delay.

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

Authorities of the Länder

Pursuant to Article 70 of the Basic Law [1A-1], averting of danger by disaster control is a task of the Länder which, to this end, passed the disaster control laws. The implementation falls under the responsibility of the authorities of the interior of the Länder and, depending on the respective Land, is delegated to the regional or also to the local level. The nuclear supervisory authorities and the radiation protection authorities of the Länder provide their support (→ Figure 5-2).

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 intervention reference level, precautionary radiation protection measures are necessary for these regions, too. In such cases, close coordination between the Land authorities responsible for disaster control and the federal authorities responsible for radiation protection is required. However, in order to protect the public, the averting of danger (disaster control) ranks on principle higher than precautionary radiation protection. This is particularly important when it comes to the specification of primary protective measures and the distribution of resources.

In case of Länder–specific events, BMU takes on a coordinating role; depending on the issues to be discussed, expert committees like RSK, SSK and the subordinate authorities like BfS and the authorised expert organisation of the Federal Government GRS also participate in the discussions.

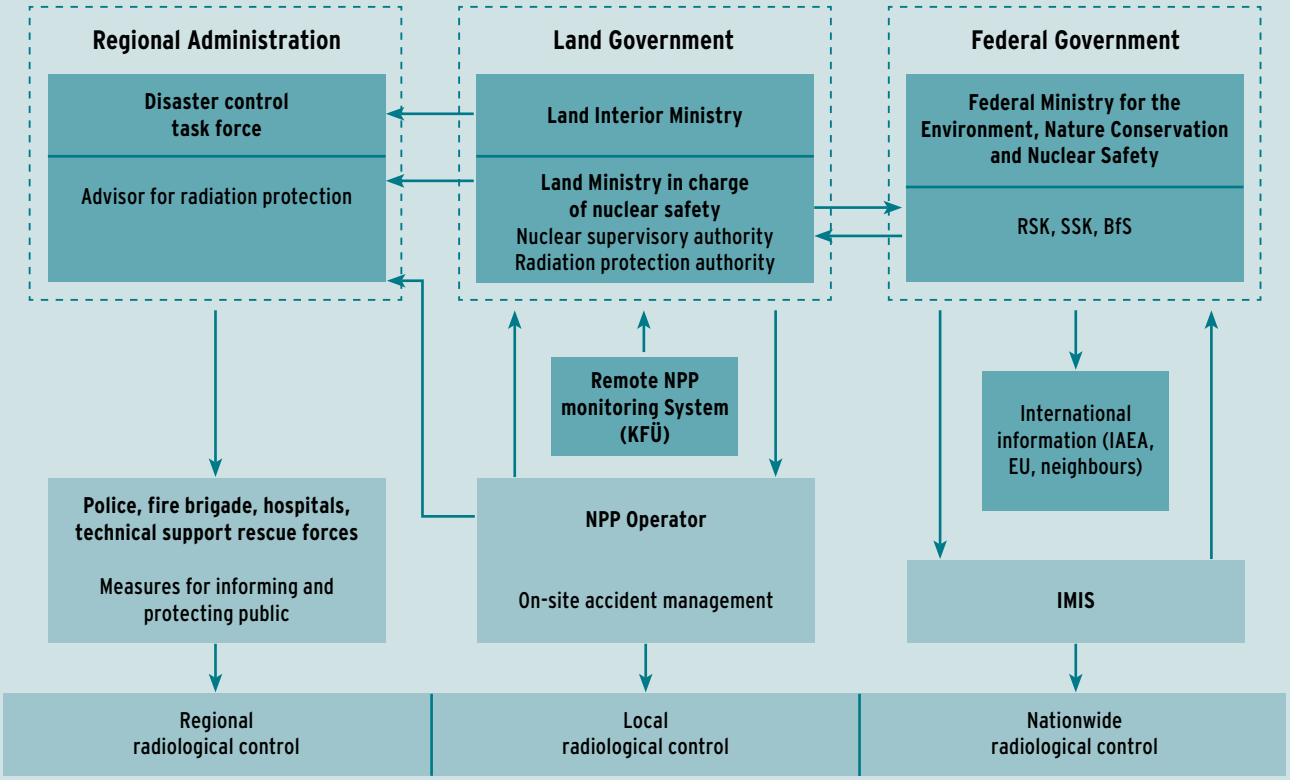
To ensure a uniform approach in the planning and possible implementation in the case of an event, the BMU developed, with the support of the Commission on Radiological Protection and in cooperation with the Länder, the “Basic Recommendations for Emergency Preparedness in the Environment of Nuclear Facilities”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

The BMU is responsible for the fulfilment of the international information and reporting obligations, e.g. for the implementation of the Convention on Early Notification of a Nuclear Accident [1E-2.4], the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency [1E-2.4] and the information exchange for radiological emergencies according to bilateral agreements.

The responsible disaster control authorities prepare special disaster control plans for the vicinity of the plants. They continuously update the plans and review them at regular intervals (in principle annually). Primary objective of the planning of disaster control is, in case of accidental release, to prevent or mitigate direct consequences from the accident on the public. The content of the planning is based on the “Basic Recommendations” [3-15.1]. The disaster control plans focus on the co-action of the planning of the disaster control authorities and of measures of the plant operator and on the implementation of the measures for protection of the public. Moreover, part of the planning are the measurements required for determining the situation.

An important aspect of planning is the information transfer between the authorities and, in particular, the alerting of the authorities by the plant operator. In this respect, RSK and SSK recommended “Criteria for Alerting the Disaster Control Authority by the Operator of a Nuclear Installation” [4-2, 4-2.1].

Figure 5-2 Emergency preparedness organisation



According to these, the plant operator defines in the alarm regulation plant-specific emission and immission criteria and technical criteria for early warning or an emergency alert which, when reached, require alerting the disaster control authorities with specification of the respective alert level. In addition, alerting the disaster control authorities is also possible by the responsible supervisory authority.

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

Situation assessment

The determination of the situation is performed at a radiological situation centre with the available information about plant state, meteorological situation and emission and immision situation. First, it is based on prognoses and later increasingly on measurement in the surrounding area.

With the decision support system RODOS it is possible to calculate local and regional consequences of releases as well as the effect of protective actions, thus making available situation information and impact assessment to the authorities as decision support.

The development of the wide-range radiological situation in Germany is determined and presented by means of the integrated measurement and information system (IMIS) which provides information used as support in taking decisions on measures of precautionary radiation protection.

In addition to the computer-based system RODOS, two documents are available: "The Guidance for the Expert Advisor for Radiation Protection of Disaster Control Management in Case of Nuclear Emergencies" [4-4] with the associated explanatory report [4-4.1] and the so-called Catalogue of Measures [4-3] "Survey of Measures for the Reduction of Radiation Exposure after Events with Significant Radiological Consequences" (Vol. 1 and 2) which provide additional help and support.

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

The Catalogue of Measures [4-3] deals with preventive health protection and here especially with measures in the area of agriculture. It documents, among others, derived target and reference values as decision basis.

Off-site measures

Criteria for protective actions

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

- Severe deterministic effects shall be avoided by measures for reducing the individual radiation dose to limits below the threshold doses for these effects.

- The risk of stochastic effects for individuals shall be reduced by appropriate measures.

- The measures for the persons affected shall provide more benefit than harm.

The "Radiological Bases" [3-15.2] explain, in particular, the intervention reference levels (as pre-defined planning values) as thresholds for consideration of the implementation of appropriate disaster control measures to reach the objectives mentioned in case of radionuclide release after a nuclear accident.

Protective actions in the area affected for averting of danger

Off-site emergency planning refers to the preparation and performance of measures for protecting the public from the effects of radionuclide releases caused by incidents or accidents and leading to contaminations and increased radiation exposure.
The measures "sheltering" and "evacuation" are preplanned for an area with a radius of up to 10 km around the nuclear power plant.

For the measure "taking iodine tablets", the tablets are, depending on the planning area, pre-distributed of held in stock locally. Instruction sheets for informing the public on the use of iodine tablets are contained in the "Radiological Bases" [3-15.2].

In addition to these measures, to prevent incorporation doses by ingestion of freshly harvested foodstuffs, a precautionary warning against consumption of such foodstuffs will be issued. This precaution will be adapted to the current situation as soon as corresponding data from measurements are available.

Beyond these protective actions, the "Basic Recommendations" [3-15.1] include a list of further measures to be considered in the planning.

Some of these measures also serve the purpose of precautionary radiation protection and are taken according to the Catalogue of Measures [4-3].

Protective measures of precautionary radiation protection for risk minimisation

In those areas where disaster control measures are not justified, the measures of precautionary radiation protection serve to reduce the radiation exposure of the public.
One focal point of the Catalogue of Measures [4-3] developed for this purpose are measures of precautionary radiation protection in form of recommendations for protective actions for the public and a large number of measures in the area of agriculture to prevent or reduce contamination of agricultural products and agricultural surfaces.

Other measures of precautionary radiation protection taken into consideration also comprise temporary and long-term resettlements.

Informing the public

The most important issues about which the public in the vicinity of a plant has to be informed at least every five years concern, among others:

- basic terminology and related explanation on radioactivity and its impacts on humans and the environment,
- radiological emergencies and their consequences for the public and the environment, including planned rescue and protective actions,
- information on how the affected persons will be alerted and how they will be continually updated on the development of the situation and
- information on how the affected persons should behave and what they should do.

This information is realised by means of a brochure, financed by the plant operators, which is posted to the public living in the vicinity of a nuclear installation in coordination with the disaster control authorities.

In case of a safety-relevant event at a nuclear installation leading to a radiological emergency in the surrounding area, the competent authorities inform the potentially affected public without any delay according to Section 51 (2) of the Radiation Protection Ordinance and give information on how to behave including specifications on health protection measures to be taken. The information to be given to the public are summarised in Appendix XIII, Part A of the Radiation Protection Ordinance and con-cern, among others:

- type and characteristics of the event, in particular origin, dispersion and expected development of the situation,
- protection instructions and measures for certain groups of the population and
- designation of the authorities responsible for disaster control
- also in case of pre-alarm level (early warning), respective information are to be given to the public.

The “Guideline for the information of the public in case of nuclear accident” [4-12] published by SSK contains suggestions for a concept for further specification. In addition to regulations concerning responsibilities, it contains procedures according to which the different institutions involved coordinate the contents of their information. Furthermore, it specifies how the citizens are enabled to contact the authorities responsible for disaster control and the media via which the public will be informed. Sample texts on this are laid down in the “Basic Recommendations” [3-15.1]. The suitability of the prepared measures to inform the public is reviewed in the exercises.

Informing the public also means that the disaster control plans, with the exception of personal and security-sensitive information, may be viewed by the public.

5.1 A short discussion or overview of the topic analysis performed by the Contracting Party

See Section 5.3

5.2 Activities performed by the operator

Does not apply.

5.2.1 A short discussion or overview of the actions taken or planned by the nuclear power plant (NPP) operator to address the topic

Does not apply.

5.2.2 Schedules and milestones to complete the operator's planned activities

Does not apply.

5.2.3 Preliminary or final results of these activities, including proposals for further actions

Does not apply.

5.3 Activities performed by the regulator:

5.3.1 A short discussion or overview of the actions taken or planned by the regulatory body to address the topic

The BMU has initiated a working group within the SSK for a review of the German rules and regulations in the light of the lessons learned from the Fukushima accident.

Revision of the German rules and regulations on emergency preparedness

In addition to the stress test of the nuclear power plants, the BMU has tasked the Commission on Radiological Protection (SSK) with the revision of the rules and regulations on the emergency preparedness in the light of the Fukushima accident. The accident sequence in Fukushima differed widely from the accident in Chernobyl, such that new experiences have been gained in the field of emergency preparedness; thus making a revision of the rules and regulations on emergency preparedness necessary.

Based on this first evaluation, the group of experts established a work programme. The available accident assessments carried out by the Japanese authorities and the International Atomic Energy Agency (IAEA), the RSK safety review, the experience and observations of the SSK emergency response staff and

the members of the expert group are the basis of the work program. To ensure an effective and efficient working, apart of the experiences gained from the Fukushima accident also the optimisation measures to be implemented within the framework of continuous improvement of the German emergency preparedness were added to the work program. Furthermore, the effect of the decided phase-out of nuclear energy on the emergency preparedness in Germany shall be analysed and taken into account.

The Länder participate in the respective working groups at the Federal/Länder level.

5.3.2 Schedules and milestones to complete the regulatory body's planned activities

The SSK working group "experience feedback Fukushima" has started its work in 2011. The work-related issues are prioritised and managed according to a schedule agreed also with the Fukushima working group of the Conference of Interior Ministers.

5.3.3 Preliminary or final results of these activities, including proposals for further actions

Final results of the SSK working group are not yet available.

5.4 Synoptic table of the activities described in 5.2.1, 5.2.2, 5.2.3, 5.3.1, 5.3.2 and 5.3.3

	Activities performed by the operator			Activities performed by the regulator		
Activities	(Section 5.2.1) Activities • performed? • ongoing? • planned?	(Section 5.2.2) Schedules or milestones to complete the planned activities	(Section 5.2.3) Available results • Yes? • No?	(Section 5.3.1) Activities • performed? • ongoing? • planned?	(Section 5.3.2) Schedules or milestones to complete the planned activities	(Section 5.3.3) Available conclusions • Yes? • No?
Topic 5 – Emergency Preparedness and Response and Post-Accident management (Off-Site)						
SSK working group "Experience feedback Fukushima"				ongoing	not yet determined	no

6 TOPIC 6 – INTERNATIONAL COOPERATION

International agreements

The legal obligation in Europe for a cross-border participation of the competent authorities was transposed into German law by a corresponding amendment of the Nuclear Licensing Procedure Ordinance. Accordingly, the competent authorities of neighbouring countries will be involved in the licensing procedure if a project could considerably affect the other country.

Germany signed the Espoo Convention on Environmental Impact Assessment in a Transboundary Context. The European Community also ratified the agreement, however limited to the application of the provisions among the member states.

In accordance with Article 37 of the EURATOM Treaty, the European Commission will be informed of any plan for discharging radioactive material of any sort. For this purpose, general information on the planned discharge, on the site and the essential characteristics of the nuclear installation are reported to the Commission six months before the competent authority issues a licence permit for the discharge in question. This serves to establish the possible impacts on the other member countries. After a hearing with a group of experts, the Commission presents its position on the case of intended discharge.

Bilateral agreements with neighbouring countries

From a very early stage, Germany took up cross-border information exchange in connection with the construction of nuclear installations in the border regions.

At present, bilateral agreements regarding the exchange of information on those nuclear installations built in the border regions exist with seven of the nine neighbouring countries of Germany (the Netherlands, France, Switzerland, Austria, the Czech Republic, Denmark and recently Poland).

Joint commissions for regular consultations on questions of reactor safety and radiation protection were formed with the Netherlands, France, Switzerland, Austria and the Czech Republic. The information exchange on nuclear installations in the border region concerns the following:

- technical or licensing relevant modifications on nuclear installations in the border region,
- operating experience especially with regard to reportable events,
- general reports on developments in nuclear energy policy and in the field of radiation protection and
- regulatory development of the safety requirements especially with regard to accident management measures in the case of severe accidents.

Altogether, the German legal regulations, the bilateral agreements and the joint commissions put neighbouring countries in a good position to independently assess the impacts nuclear installations in border regions will have on the safety of their own country.

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

Exercises with scenarios of a radiological event are also carried out at the international level. On principle, BMU representatives take part – in line with their respective responsibilities – in the regular exercises of the EU (ECURIE exercises), the IAEA (CONVEX exercises) and the OECD/NEA (INEX exercises), in which supporting agencies, other federal ministries and the relevant Länder authorities also participate depending on the situation.

Regarding further development and harmonisation of nuclear emergency preparedness regulations at an adequate high international level, representatives of the BMU and other organisations participate for Germany in the relevant commissions at OECD/NEA, IAEA and the EU as well as in a working group (WGE) on radiation emergency preparedness of the European association of the top regulators in the field of radiation protection (Heads of European Radiation Control Authorities, HERCA).

In Länder with nuclear installations close to the border, cross-border disaster control exercises are conducted at longer intervals.

Information of neighbouring countries

In the event of an emergency, the measurement data acquired within the monitoring programmes and the situation assessment of the plant operator will be the basis for reporting in accordance with the EU agreement on rapid information exchange [1F-4.1] and the Convention on Early Notification of a Nuclear Accident [1E-2.4]. They also serve as basis for the information exchange for fulfilling bilateral agreements. This ensures that Germany's neighbouring countries will receive timely information. The measurements routinely performed in accordance with the Guideline on Emission and Immission Monitoring [3-23] are also used for the reports to the EU in accordance with Article 36 of the EURATOM Treaty.

Germany has signed bilateral agreements regarding mutual assistance in the case of an emergency with all of the nine neighbouring countries. Moreover, assistance agreements have been concluded with Lithuania, Hungary and the Russian Federation. Similar agreements with Italy and Bulgaria have been initialled or are in preparation. Due to such agreements, there are direct information and data exchanges at the regional level at nuclear power plant sites near the border between the respective disaster control authorities or organisations for determining the radiological situation.

Further international activities

Germany is a member of the Western European Nuclear Regulators Association (WENRA) and of the International Nuclear Regulators' Association (INRA); furthermore, as a member of the European Union, Germany is represented in the European Nuclear Safety Regulators Group (ENSREG).

6.1 A short discussion or overview of the topic analysis performed by the Contracting Party

During the IRRS Follow-Up-Mission, the German supervisory authority has been assessed based on the updated module "Global Nuclear Safety Regime". Regarding this aspect, the IRRS team came to the conclusion that Germany has ratified all essential international agreements and conventions in the field of nuclear safety and emergency preparedness including the "Convention on Nuclear Safety" and the "Convention on Early Notification of a Nuclear Accident".

Germany actively promotes multilateral and bilateral cooperation to improve the safety by harmonised methodologies, especially with regard to the accident management. There are conventions and arrangements with many countries on the cooperation in the field of nuclear safety and accident management; in case of neighbouring countries, agreements are made between the BMU and the competent foreign authorities. The Länder are also involved in bilateral committees with neighbouring countries in the field of accident management, nuclear safety and radiation protection. The supervision authorities and their TSOs consider the Safety Standards and the relevant IAEA codes of conduct, also when developing KTA Safety Standards. Furthermore, some IAEA Peer Review Safety Missions were already carried out in Germany, e.g. International Regulatory Review Service (IRRS) and Operational Safety Review Team (OSART). Germany has not yet inviting to the Emergency Preparedness Review (EPREV) Mission; EPREV is a service to appraise preparedness for nuclear and/or radiological emergencies in Member States.

6.2 Activities performed by the operator

6.2.1 A short discussion or overview of the actions taken or planned by the nuclear power plant (NPP) operator to address the topic

German nuclear power plant operators are involved in many international committees partly via the VGB PowerTech, partly on its own responsibility (ENEF, EUR, ENISS, Eurelectric, WANO etc.).

Activities performed by the operator within the World Association of Nuclear Operators (WANO): Realignment after Fukushima

As a consequence of the Fukushima Daiichi accident, the World Association of Nuclear Operators (WANO) decided to expand their program and to improve the quality of service. In October 2011, 600 participants attended the 11th WANO Biennial General Meeting (BGM) in Shenzhen, China. There, proposals for the establishment of a "new WANO" have been discussed and approved by the members. Decisions may be summarised as follows:

- WANO will expand the scope of the WANO-Peer-Reviews and of other WANO programs in order to focus not only the prevention of a nuclear accident, but also the limitation of its consequences.
- WANO will expand the WANO-Peer-Review measures, to conduct Peer Reviews in nuclear power plants and a Corporate Peer Review at each member company within the next six years.
- WANO will improve the quality of their activities and services, starting from the careful self-assessment of each WANO regional centre and of the WANO central office in London.
- WANO will increase its workforce of all four regional centres by experienced employees in order to fulfil their growing tasks.

German WANO members have supported the efforts to improve the WANO services from the outset and have acceded the WANO Post-Fukushima Commission which was established to develop recommendations for a "new WANO". German WANO members commit themselves to the objectives of the "new WANO". In order to support the or-ganisation in the

realisation of these objectives, German WANO members will provide expert knowledge and staff to arrange details for the "new WANO". Regardless the German Government's phase-out policy, German WANO members will maintain all ac-tivities for nuclear power plants in operation. These include Peer Reviews, Technical Support Missions and Workshops (organisation and attendance), as well as reporting of special events and WANO performance indicators.

Continuation of the WANO Peer Reviews for the German nuclear power plants

WANO-Peer-Reviews are initiated by the operator. Here, the safety-relevant nuclear power plant processes are assessed. WANO-Peer-Reviews were conducted successively for all plants in operation. The following plants were audited: Grohnde (1997), Grafenrheinfeld, (1999), Gundremmingen (2000), Neckarwestheim (2001), Brunsbüttel (2001, 2005 and 2010), Isar (2003), Emsland (2004 and 2010), Brokdorf (2005 and 2011), Biblis (2005), Unterweser (2005), Krümmel (2006 and 2009), Gundremmingen (2007), Grafenrheinfeld (2007), Grohnde (2007), Isar (2009), Philippsburg (2009).

Processing of the WANO Significant Operation Experience Reports (SOER)

For German nuclear power plants, a process for the WANO Significant Operating Experience Report (SOER) has been established. Due to the central distribution of the SOERs and coordination of their response, it is ensured that the plant-specific relevance and the safety significance of the issues are assessed in each plant. In the aftermath of the Fukushima accident WANO issued a Significant Operating Experience Report (SOER); the reviews suggested in the WANO-SOERs were already covered to a considerably extent by the RSK Safety Review initiated in Germany. Meanwhile, responses have been sent to WANO and are entirely equivalent with the above mentioned measures.

Activities performed by the operator within the European Nuclear Installations Safety Standards ENISS

Shortly after the Fukushima accident, energy ministers, regulators, experts and representatives of industry agreed on the need for a comprehensive risk and safety assessment (the so called "stress test") to be carried out for the European nuclear power plants.

The European Nuclear Installations Safety Standards (ENISS) group, under the auspices of FORATOM bringing together operators and specialists from the nuclear industry at European level played a very important role in laying down of the criteria for the EU stress test.

ENISS developed a special working group to draw up the Safety Terms of Reference (STORE), i.e. safety related tasks with the participation of German licence holders. This group had to work on developing the methodology of the assessments of plants in operation and under construction and developed criteria for the assessment of robustness in case of extreme naturally-caused events. The ENISS-STORE working group has conducted a comprehensive review of the WENRA stress test proposals and has especially analysed the scope, methodology and time frame of these. Comments and amendments of the STORE working group have been sent to WENRA. Many comments have been taken into consideration in the final version of the WENRA document.

In parallel to the work of WENRA, the "Working Group Risks" of the European Nuclear Energy Forum (ENEF) decided to establish a Task Force (TF) around the ENEF Sub-Working Group Nuclear Installation Safety, SWG NIS on nuclear installation safety. SWG NIS was asked to draw up a proposal of the ENEF contribution ("SAFETY TERMS OF REFERENCE [STORE] Targeted Safety and Risk Reassessment applicable to Nuclear Power Plants in the EU in the light of the Fukushima events").

The ENEF contribution has been discussed and approved at the "Working Group Risks" meeting on 4th May 2011. After approval, this contribution has been sent to the EU Commission, to WENRA and ENSREG. After that, the STORE working group has worked out a proposal for the content of the annual report of the plant operator (Terms of Contents – TOC) which synthesise the Complementary Safety Assessments (the so called stress test) carried out for nuclear power plants. The document has been discussed with WENRA; the ENISS proposal was taken into consideration.

After transmission of the EU stress test reports by the licence holders, the STORE working group held a meeting to exchange experience and information on new measures introduced by the licence holders. This is an ongoing process i.e. not yet completed and will continue well into 2012.

6.2.2 Schedules and milestones to complete the operator's planned activities

For a second cycle for the performance of WANO peer reviews, the following proposal on scheduling was made: Emsland (2010), Brokdorf (2010), Brunsbüttel (2010), Neckarwestheim (2011), Biblis (2011), Unterweser (2011) and Krümmel (2011). Due to the Fukushima accident the review at Neckarwestheim is delayed until November 2012, a follow-up auditing at the nuclear power plant Phillipsburg was performed in March 2012.

After the Fukushima accident no OSART mission has been performed so far.

6.2.3 Preliminary or final results of these activities, including proposals for further actions

Details on schedules and milestones are described in the previous section. Operators continue to hold on to regular WANO-Peer-Reviews; to be able to act internationally at the highest level, the preparation of information notices (WANO SOER) and processing of information and recommendations of previous missions are prompt and comprehensive.

The OSART missions performed in Germany to date, demonstrated practices and procedures which are exemplarily for other nuclear power plant in the world. Furthermore, the work on IAEA input attracted international attention. It was also established that improvements are implemented, where possible, across locations and sites. Overall, a high level of commitment and management of safety and safety culture was certified. International and European developments are accompanied actively and aligned in a coordinated process.

Operators will continue to support OSART missions at their sites in the future, and will work on recommendations, especially regarding factors from the areas man and organisation.

6.3 Activities performed by the regulator

6.3.1 A short discussion or review of the actions taken or planned by the regulatory body to address the topic

In the light of the Fukushima accident, the European Council decided to perform a re-evaluation of the European nuclear power plants safety (stress test). ENSREG and the commissions specified the scope and modalities of the re-evaluation in accordance with the lessons learned from the Fukushima accident making full use of the WENRA expert knowledge. The stress test was started on 1st June 2011, at national level. The progress report was submitted on 15th September and the final report on 31st December 2011.

After the reporting, the stress test procedure envisages a so called "peer review". Questionnaires on the performance and purpose of the peer reviews were developed by ENSREG with German participation.

The Peer Review has been conducted in three phases:

1. Pilot Review
2. Topical Review (Horizontal Review)
3. Country Review (Vertical Review)

For the Pilot Review, Germany provided a part of its National Report. Furthermore, Germany has actively participated in all three review phases.

In the frame of the CNS Extraordinary Meeting in August 2012, the improvement of the CNS process will be discussed. Germany, with the collaboration of its European partners, submitted proposals.

Furthermore, after the Fukushima accident, the BMU has actively participated in all essential conferences and activities of the EU, the IAEA and NEA.

6.3.2 Schedules and milestones to complete the regulatory body's planned activities

Additionally, the BMU will actively participate in conferences and activities of the EU, the IAEA and the NEA for analysis of the accident sequence in Fukushima and for im-plementation of necessary measures.

6.3.3 Preliminary or final results of these activities, including proposals for further actions

Does not apply.

6.4 Synoptic table of the activities described in 6.2.1, 6.2.2, 6.2.3, 6.3.1, 6.3.2 and 6.3.3

	Activities performed by the operator			Activities performed by the regulator		
Activities	(Section 6.2.1) Activities • performed? • ongoing? • planned?	(Section 6.2.2) Schedules or milestones to complete the planned activities	(Section 6.2.3) Available results • Yes? • No?	(Section 6.3.1) Activities • performed? • ongoing? • planned?	(Section 6.3.2) Schedules or milestones to complete the planned activities	(Section 6.3.3) Available conclusions • Yes? • No?
Topic 6 – International Cooperation						
WANO Peer Review GKN II	planned	November 2012	no			
WANO Peer Review follow up KKP	performed	March 2012	no			
ENSREG Stress Test				performed	completed	yes
CNS Extraordi-nary Meeting				ongoing	ongoing	no

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CNS-03	Behandlung auslegungsüberschreitender Ereignisabläufe für die in der Bundesrepublik Deutschland betriebenen Kernkraftwerke mit Druckwasserreaktoren, Positionspapier der RSK zum anlageninternen Notfallschutz im Verhältnis zum anlagenexternen Katastrophenschutz, Ergebnisprotokoll der 273. RSK-Sitzung am 09.12.1992
CNS-04	Maßnahmen zur Risikominderung bei Freisetzung von Wasserstoff in den Sicherheitsbehälter von bestehenden Kernkraftwerken mit Druckwasserreaktor nach auslegungsüberschreitenden Ereignissen, Ergebnisprotokoll der 314. RSK-Sitzung am 17.12.1997
CNS-05	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, gebilligt in der 244. Sitzung der SSK am 03.November 2010, Verabschiedet in der 429. Sitzung der RSK am 14. Oktober 2010
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CNS-13	EU Stresstest National Report of Germany Implementation of the EU Stress Tests in Germany 31.12.2011

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1A-3	Gesetz über die friedliche Verwendung der Kernenergie und den Schutz gegen ihre Gefahren (Atomgesetz AtG)
1A-8	Verordnung über den Schutz vor Schäden durch ionisierende Strahlen (Strahlenschutzverordnung – StrlSchV) vom 20. Juli 2001 (BGBl.I 2001, Nr. 38, S. 1714), zuletzt geändert durch Artikel 3 des Gesetzes vom 13. Dezember 2007 (BGBl.I 2007, Nr. 65, S. 2930), Dosiskoeffizienten in BAnz 2001, Nr. 16
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Abbreviations

AHRS	Auxiliary heat removal system
AM	Accident management
AtG	Atomic Energy Act
ATWS	Anticipated transient without scram
BfS	Federal Office for Radiation Protection
BGM	Biennial General Meeting
BMU	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
CNS	Convention on nuclear safety
CONVEX	Convention exercise
CSA	Complementary Safety Assessments
DC	Direct-current
DSHA	deterministic seismic hazard assessment
ECURIE	European Community Urgent Radiological Information Exchange
ENEF	European Nuclear Energy Forum
ENISS	European Nuclear Installation Safety Standards
ENSREG	European Nuclear Safety Regulators Group
EPREV	Emergency Preparedness Review
EU	European Union
EUR	European Utility Requirements
EURATOM	European Atomic Energy Organisation
FORATOM	Forum Atomique Européen
GKN	Gemeinschaftskraftwerk Neckarwestheim
GRS	Gesellschaft für Anlagen- und Reaktorsicherheit mbH
HERCA	Heads of European Radiation Control Authorities
IAEA	International Atomic Energy Agency

IMIS	Integrated Measurement and Information System
INEX	International Nuclear Exercise
IRRS	Integrated Regulatory Review Service
KBR	Kernkraftwerk Brokdorf
KKB	Kernkraftwerk Brunsbüttel
KKE	Kernkraftwerk Emsland
KKG	Kernkraftwerk Grafenrheinfeld
KKI	Kernkraftwerk Isar
KKK	Kernkraftwerk Krümmel
KKP	Kernkraftwerk Philippsburg
KKU	Kernkraftwerk Unterweser
KKW	Kernkraftwerk
KRB	Kernkraftwerk Gundremmingen
KTA	nuclear safety standard
KWB	Kernkraftwerk Biblis
KWG	Kernkraftwerk Grohnde
KWO	Kernkraftwerk Obrigheim
LAA	Länder Committee for Nuclear Energy
MSK	Medwedew-Sponheuer-Karnik-Skala
NEA	Nuclear Energy Agency
NIS	Nuclear Installation Safety
NPP	Nuclear power plant
OECD	Organisation for Economic Co-operation and Development
OSART	Operation Safety Review Team
PSA	Probabilistic safety analysis

PSHA	Probabilistic seismic hazard assessment
RSK	Reactor Safety Commission
RSK-SÜ	safety review of the German NPPs
SAMG	Severe Accident Management Guideline
SAMP	Severe Accident Management Program
SBO	station blackout
SOER	Significant Operating Experience Report
SSK	Commission on Radiological Protection
STORE-TF	Safety terms of references – Task force
StrlSchV	Radiation Protection Ordinance
SWG NIS	Sub-Working Group Nuclear Installation Safety
TOC	Terms of Contents
TSO	Technical Support Organisation
UNS	Autonomous second-level emergency system
USUS	Autonomous sabotage and accident protection system
VDE	Association of Electrical, Electronic and Information Technologies e.V.
WANO	World Association of Nuclear Operators
WENRA	Western European Nuclear Regulators Association
WG	Working Group
WGE	Working Group Emergencies
WLN	Information Notice

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