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Stress test Follow-Up Actions

Issue Paper for Germany

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Prepared by the Order of the BMLUFW
(BMLFUW-ZI.UW.1.1.3/0020-V/6/2011)

Report, Final version
Vienna, 20-01-2014

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1. Introduction

The EU post Fukushima Stress tests provided important insights into the robustness but also the vulnerabilities of individual NPP sites and units. Even during the performance of the Stress tests, having identified safety weaknesses, many plants embarked on modifications and safety improvements, in particular by adding mobile equipment. Following the completion of the Stress tests, all EU countries operating nuclear power plants prepared National Action Plans defining safety improvement measures and their implementation schedule. The National Action Plans addressed specific vulnerabilities found during the stress tests but also other elements, like safety improvements identified by other analyses or peer reviews.

Achieving and maintaining a high level of safety of NPPs in the neighbouring countries is of high interest to Austria. An important part of this is the understanding of and information concerning the implementation of the safety improvements, which are designed to rectify the vulnerabilities identified during the Stress tests, as well as other safety improvements. In order to identify the issues and safety improvements that are of highest relevance to Austria, the Federal Ministry for Agriculture, Forestry, Environment and Water Management engaged a group of Consultants (Project team) to undertake an in depth analysis of the Stress test reports, (including operators' and regulators'), the Extraordinary CNS reports, the National action Plans but also some other sources like bilateral meetings and other previous discussions. The results of the analysis for Germany are provided in the attached report.

Using the sources as described above, a set of safety issues and improvement measures of high interest for each of the neighbouring countries have been identified. Those issues and measures, following the same structure as used during the Stress test, are grouped into three categories:

- Topic #1: Initiating Events (Earthquake, flooding and extreme weather)
- Topic #2: Loss of Safety Systems
- Topic #3: Severe Accident Management

For Germany, there is an additional issue not directly related to the stress tests ("Topic #X"), which was subject to discussions in Germany during the last years. This issue is also considered as important by the Austrian side.

In each category relevant safety issues are listed. For each issue, the safety relevance and background information are provided. The information is, in general, taken from available reports and sources, and extended by the analyses of the Project team. The Project team provided its own estimates of the safety importance, as well as the expected schedule for the implementation. The latter (generally) reflects the schedules as provided by each country in the National Action Plan, though in some cases modified on the basis of perceived safety importance. Finally, the analysis of each of the safety improvements contains an entry called "To be discussed". In this entry, the specific details are summarized which are relevant for each specific safety issue and are considered to be of particular interest by the Project team, and that are proposed to be discussed during bilateral meetings.

With the selection of safety issues and improvement measures, it is intended to open the discussion during the regular annual bilateral meetings with each of the neighbouring countries. It is expected that each of the safety issues and improvement measures will be followed up upon to their final implementation or resolution.

In order to assure that the safety improvements are discussed commensurate to their actual safety relevance, a categorisation of the issues has been proposed. With the analysis as described above, all the issues are grouped in 3 categories. The categorisation reflects the perceived safety importance of each issue or measure, but also reflecting the amount (and clarity) of information currently available. The three categories, in the increasing level of complexities are:

- Check list
- Dedicated presentation
- Dedicated workshop

The “**check list**” is assigned to the safety issues/improvement measures that are in general understood and specifics of those are either known or obvious. Considering this, it is expected that a short presentation is made describing the status and announcing the schedule for the completion of the issue/improvement measure.

The “**dedicated presentation**” is the next higher category. For issues/safety improvements in that category, it is expected that the countries will provide a dedicated presentation, where the relevant specifics of the issue or improvement measure will be highlighted in more details. This is expected to include e.g. the design concept, the specifics of the construction/implementation/analysis or the planned operation of a modification. The list in the “to be discussed” entry indicates the main (though not necessarily all) the elements that are of interest.

For the issues of greatest safety significance but also for those of high complexity, or for the issues where the design solution is not known or many alternatives exist, the Project team recommends that a “**dedicated workshop**” is organized. In this, the country would present all related details on the issue to enable the Austrian side to ask clarifying questions, to assure full understanding of the concept, details of installation/operation or any other element that is relevant for the issue/improvement measure. To increase the efficiency, some of the workshops are meant to address several related subjects in as one set.

It is generally expected that each safety issue or improvement measure will remain on the agenda of bilateral meetings until the final completion and clarification. This does not mean that for each of the issues/improvements, a specific action (e.g. a workshop) would to be made in each of the bilateral meetings. Rather, it is expected that in the course of the next several meetings all the issues will be addressed in accordance with a mutually agreed work plan.

2. Glossary

AC	Alternate Current
AFW	Auxiliary Feedwater
AHRS	Additional Heat Removal System
AM	Accident Mitigation
AMP	Ageing Management Program
ANSYS	Analysis System (finite element software)
ASME	American Society of Mechanical Engineers
ASTEC	Accident Source Term Evaluation Code
BD	Czech for Control Room (Bloková Dozorna)
BDB	Beyond Design Basis
BDBA	Beyond Design Basis Accident
BHB	German acronym for Operating Manual
BSVP	Czech for Spent Fuel Storage Pool (Bazén Skladováni Vyhořelého Paliva)
BMU	German Federal Ministry for the Environment
BWR	Boiling Water Reactor
CCW	Component Cooling Water
CW	Cooling Water
CDF	Core Damage Frequency
CERES	Cooling Effectiveness on Reactor External Surface
CEZ (ČEZ)	České Energetické Závody, Czech Electrical Utility
CH	Switzerland
CISRK	Czech for Central Radiation Monitoring System (Centrální Informačni Systém Radiačni Kontroly)
CNS	Convention on Nuclear Safety
CNS EOM	CNS Extraordinary Meeting
CRP	Copper-rich Precipitates
CS	Containment Spray
ČSN	Česká Norma
CST	Condensate Storage Tank
CVCS	Chemical & Volume Control System
CZ	Czech Republic
ČEPS	Czech Transition Grid (Česká Elektrická Přenosová Oustava)
DACAAM	Data Collection and Analysis for Ageing Management
DBA	Design Basis Accident
DBE	Design Basis Earthquake
DE	Germany
DEC	Design Extension Conditions
DC	Direct Current
DG	Diesel Generator

E.ON	German Electrical Utility
EBO	Bohunice Nuclear Power Plant, Slovakia
EC	European Commission
ECC	emergency control centre
ECCS	Emergency Core Cooling System
ECR	Emergency Control Room
EDA	Power Plant Dalešice, Czech Republic
EDG	Emergency Diesel Generator
EDU	Dukovany Nuclear Power Plant, Czech Republic
EFW	Emergency Feedwater
EFWS	Emergency Feed Water System
EMO	Mochovce Nuclear Power Plant, Slovakia
EMS	European Macroseismic Scale
EnBW	Energie Baden-Württemberg AG, German Electrical Utility
ENSI	Swiss Federal Nuclear Safety Inspectorate (Eidgenössisches Nuklearsicherheitsinspektorat)
ENSREG	European Nuclear Safety Regulators Group
EOP	Emergency Operating Instructions
EPG	Emergency Power Generators
ERMSAR	European Review Meeting on Severe Accident Research
ES	Engineered Safeguards
ESCW	Essential Services Chilled Water
ESR	Electron Spin Resonance Dating
ESW	Essential Service Water
ETE	Temelín Nuclear Power Plant, Czech Republic
FWT	Feedwater Tank
GKN I	Neckarwestheim I Nuclear Power Plant, Germany
GKN II	Neckarwestheim II Nuclear Power Plant, Germany
GRS	Gesellschaft für Anlagen- und Reaktorsicherheit, Germany
GPP	Gas Power Plant
HA	Hydro Accumulator
HAEA	Hungarian Atomic Energy Authority
HCLPF	High Confidence of Low Probability of Failure
HP	High Pressure
HŘS	Czech for Emergency Control Centre (Havarijní Řídící Středisko)
HU	Hungary
HVAC	Heating, Ventilation and Air Conditioning
HZSp	Czech for Fire Brigade of the NPP (Hasičský Záchranný Sbor Podniku)
IAEA	International Atomic Energy Agency
ICTS	Information and Communication Technology Services
IRS	Incident Reporting System
ISI	In-service Inspection
IZS	Czech for Integrated Rescue System (Integrovaný Záchranný System)

I&C	Instrumentation & Control
KBR	Brokdorf Nuclear Power Plant, Germany
KKB	Beznau Nuclear Power Plant, Switzerland
KKC	Czech for Emergency Coordination Centre (Krizové Koordinační Centrum)
KKE	Emsland Nuclear Power Plant, Germany
KKG	Grafenrheinfeld Nuclear Power Plant, Germany
	Gösgen Nuclear Power Plant, Switzerland
KKI-1	Isar I Nuclear Power Plant, Germany
KKI-2	Isar II Nuclear Power Plant, Germany
KKK	Krümmel Nuclear Power Plant, Germany
KKL	Nuclear Power Plant Leibstadt, Switzerland
KKM	Mühleberg Nuclear Power Plant, Switzerland
KKP I	Philippsburg I Nuclear Power Plant, Germany
KKP II	Philippsburg II Nuclear Power Plant, Germany
KKU	Nuclear Power Plant Unterweser, Germany
KRB B	Gundremmingen Nuclear Power Plant Unit B, Germany
KRB C	Gundremmingen Nuclear Power Plant Unit C, Germany
kV	Kilovolt
kW	Kilowatt
KWB A	Biblis Nuclear Power Plant Unit A, Germany
KWB B	Biblis Nuclear Power Plant Unit B, Germany
KWG	Grohnde Nuclear Power Plant, Germany
LFRS	Lead-Cooled Fast Reactors
LOCA	Loss of Coolant Accident
LOOP	Loss of Off-site Power
LP ECCS	Low Pressure Safety Injection (within Emergency Core Cooling System)
LRF	Large Release Frequency
M	Magnitude
MCCI	Molten Corium Concrete Interaction
MCR	Main Control Room
MPa	Megapascal
MPLS WAN	Multiprotocol Label Switching Wide Area Network
MSK	Modified Mercalli Scale
NAcP	National Action Plan
ND	Czech for Emergency Control Room (Nouzová Dozorna)
NPP	Nuclear Power Plant
NRC	(US) Nuclear Regulatory Commission
OECD	Organisation for Economic Co-operation and Development
OECD/NEA	Nuclear Energy Agency of OECD
OSL	Optically Stimulated Luminescence Age dating
PAMS	Post-Accident Monitoring System
PAR	Passive Autocatalytic Recombiners

PC	Primary Circuit
PGA	Peak Ground Acceleration
PGAH	Peak Horizontal Ground Acceleration
PGAV	Peak Vertical Ground Acceleration
PSA	Probabilistic Safety Analysis
PSHA	Probabilistic Seismic Hazard Assessment
PSR	Periodic Safety Review
PTS	Pressurized Thermal Shock
PU	Power Uprate
PWR	Pressurized Water Reactor
RA	Radioactive
RCP	Reactor Coolant Pump
RCS	Reactor Coolant System
RELAP	Reactor Excursion and Leak Analysis Program (simulation tool)
RHR	Residual Heat Removal
RPV	Reactor Pressure Vessel
RSK	Reactor Safety Commission (Advisory Body to German Federal Ministry for the Environment)
RWE	German Electrical Utility
RWST	Reactor Water Storage Tank
SA	Severe Accident
SAM	Severe Accident Management
SAMG	Severe Accident Management Guidelines
SBLOCA	Small Break LOCA
SBO	Station Blackout
SCW	Service Circulating Water
SDSA	Steam Dump Station to Atmosphere
SFP	Spent Fuel Pool/pit
SFSP	Spent Fuel Storage Pool
SG	Steam Generator
SHA	Seismic Hazard Assessment
SiAnf	German Safety Requirements for Nuclear Power Plants
SK	Slovakia
SLO	Slovenia
SPSS	Secure power supply systems
SSCs	Structures, Systems and Components
StMUG	(Bavarian) State Ministry for the Environment
SÚJB	State Office for Nuclear Safety, Czech Republic
SUP	Safety Upgrade Program
SUSAN	Special Emergency System (Spezielles unabhängiges System zur Abfuhr der Nachzerfallwärme)
SW	Service Water
SWR69	German type of BWR

SWR72	German type of BWR
SZN	Czech for Safety Ensuring System (Systém Zajištění Bezpečnosti)
T_k	Ductile to Brittle Transition Temperature
TSC	Technical Support Centre
TVD	Czech for Essential Service Water (Technická Voda Důležitá)
UHS	Ultimate Heat Sink
UPS	Czech for Uninterruptible Power Supply (Nepřerušitelný Zdroj Elektrického Napájení)
V	Volt
VE	Czech for Hydroelectric Power Station (Vodní Elektrárna)
VVER	Water-Water-Energy-Reactor (reactor type of Soviet provenience)
WANO	World Association of Nuclear Operators
ZUNA	German acronym for AHRS

3. Summary of the findings

SUMMARY TABLE Stresstest Follow-Up Action: Issues for Monitoring, Germany				
Issue	Title	Safety importance	Follow-up	
			Action	Schedule
TOPIC 1: Initiating Events				
DE 1.1	KBR, KWG, KKG and KKI: Application of IAEA's suggested minimum level of 0.1g as the seismic design basis	High	Dedicated presentation	2Q/2015
DE 1.2	KKP and GKN: Seismic hazard assessment for Rhine Graben region	High	Dedicated presentation	2Q/2015
TOPIC 2: Loss of Safety Systems				
DE 2.1	Increase of availability and operability of emergency power supply (for those NPPs where such measure is not yet implemented)	High	Dedicated presentation	2Q/2014
DE 2.2	KBR: Increase the capability of residual heat removal	High	Check list	2Q/2014
DE 2.3	Enhancement of SFP cooling	Medium	Check list	2Q/2015
TOPIC 3: Severe Accident Management				
DE 3.1	Availability of accident management measures in case of design basis natural hazards	High	Dedicated workshop	4Q/2014
DE 3.2	Measures to improve the reliability of the ultimate heat sink	High	Dedicated presentation	2Q/2014
DE 3.3	Accident management measures in case of an internal flooding of the annulus in the reactor building of German PWRs	High	Dedicated presentation	2Q/2016
DE 3.4	Development of AM measures in case of a load drop	Medium	Dedicated presentation	2Q/2017
DE 3.5	Vulnerability of Spent Fuel Pools at smaller BWRs of type SWR69 (permanently shut down) to airplane crash	Medium	Dedicated presentation	2Q/2015
DE 3.6	Spent Fuel Pool at Gundremmingen NPP (KRB II)	Medium	Dedicated presentation	2Q/2016
TOPIC X: Outside Topics 1 - 3				
DE X.1	Seismic design of residual heat removal and emergency core cooling system at Gundremmingen NPP (KRB II)	Medium	Dedicated presentation	2Q/2015

3.1 Topic 1: Initiating Events (Earthquake, flooding and extreme weather)

Germany	
Topic 1: Initiating events	
Issue No	**DE 1.1**
Title	KBR, KWG, KKG and KKI: Application of IAEA's suggested minimum level of 0.1g as the seismic design basis
Content	The design basis earthquake (DBE) values for German nuclear facilities vary between intensity VI and VIII EMS. For several sites these intensity values correspond to PGA values, which are lower than the minimum value of 0.1g recommended by IAEA in SSG-9. This finding applies to the operating plants at Brokdorf (KBR), Grohnde (KWG), Grafenrheinfeld (KKG), and Isar (KKI).
Safety relevance	IAEA (2010) suggests a minimum ground motion of 0.1g as the seismic design basis. ENSREG suggests the same ground motion value as a minimum hazard level in its recommendations resulting from the European Stress Tests (ENSREG, 2012 a): "Topic I items (natural hazards) to be considered: The use a return frequency of 10^{-4} per annum (0.1g minimum peak ground acceleration for earthquakes) for plant reviews/back-fitting with respect to external hazards safety cases."
Background	Seismic hazard assessments for intra-continental low-seismicity areas are subjected to major uncertainties due to the limitations of historical and instrumental earthquake records, and the use of ground motion prediction equations derived from other parts of the world. These uncertainties cannot be reduced and therefore do not permit hazard values to decrease below certain threshold values. For that reason, and regardless of any lower apparent exposure to seismic hazard, IAEA (2010) suggests a minimum level as the lower limit to any seismic hazard study. This minimum should be represented by a horizontal free field standardized response spectrum for a PGA value of 0.1g. ENSREG (2012 b) recommended that "the German regulatory authority should consider the possible safety impact of using PGA that is below the internationally recommended value". As seismic margins as well as the cliff edge effects for seismic events have not been determined during the Stress Tests, it is unclear whether IAEA's suggested minimum is enveloped by the safety margins of the listed NPPs. The Stress Tests documents are very unspecific in the assessment of seismic margins of the plants under consideration and refrain from systematic quantitative assessments in terms of ground motion (Federal Ministry of Environment, 2011; ENSREG, 2012 b). An assessment of the robustness of plants to beyond design basis earthquakes is addressed in the German NAcP (Recommendation N-14; Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2012). For KBR, KWG, KKG and KKI these reviews should be finalised in 2013.

	References: ENSREG (European Nuclear Safety Regulator Group) (2012 a). Compilation of recommendations and suggestions. Peer review of stress tests performed on European nuclear power plants, July 2012. http://www.ensreg.eu/node/513 ENSREG (European Nuclear Safety Regulator Group) (2012 b). Stress tests performed on European nuclear power plants; Peer review country report for Germany, April 2012. http://www.ensreg.eu/node/394 Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2011). EU Stresstest National Report Germany. http://www.ensreg.eu/node/360 Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2012). German Action Plan for the implementation of measures after the Fukushima Dai-ichi reactor accident. http://www.ensreg.eu/node/691 IAEA (2010): Seismic Hazards in Site Evaluation for Nuclear Installations. Specific Safety Guide No. SSG-9, Vienna 2010. http://www-pub.iaea.org/MTCD/publications/PDF/Pub1448_web.pdf WENRA (2013). WENRA Safety Reference Levels for Existing Reactors, Draft Version Issue T, July 2013.
To be discussed	The Project team asks for a dedicated presentation that addresses the following issues: ➢ The NAcP addresses an assessment of seismic robustness of the NPPs KBR, KWG, KKG and KKI. What is the outcome of these assessments, and what are the seismic safety margins for the safety relevant SSCs in terms of ground motion? ➢ According to N-14 of the NAcP safety margin assessments should use HCLPF (High Confidence for Low Probability of Failure) values. In cases where these values are not available the assessment should be performed “by means or applicability considerations”. The requested presentation should ensure that these “applicability considerations” meet the requirements of a reliable seismic margin assessment. ➢ Do the safety margins of the NPPs KBR, KWG, KKG and KKI envelope the 0.1g requirement, and if not, what further actions or measures have been decided to comply with ENSREG’s suggestion to use 0.1g as a minimum PGA for plant reviews/backfitting?
Safety importance	High
Safety priority	Medium term
Follow-up	Dedicated presentation

Germany	
Topic 1: Initiating events	
Issue No	**DE 1.2**
Title	KKP and GKN: Seismic hazard assessment for Rhine Graben region
Content	The periodic safety reviews, which have to be performed every ten years as required by German regulations, include a re-evaluation of external hazards and the corresponding protective measures, considering the development of the state of the art. Seismic hazard assessments for the German nuclear sites were so far exclusively based on historical and instrumental earthquake records, which are analysed by a combination of deterministic and probabilistic methods. These analyses apparently do not take into account geological and paleoseismological data from active faults of the Rhine Graben fault system.
Safety relevance	Recent paleoseismological and geological data from the Rhine Graben prove that historical and instrumental earthquake data are insufficient for assessing the seismic hazard in that area.
Background	Seismic hazard assessments for intra-continental low-seismicity areas are subjected to major uncertainties due to the limitations of historical and instrumental earthquake records. These uncertainties are particularly high in areas with slow-moving capable faults such as the faults in the Rhine Graben, and may lead to significantly underestimated hazard values. Systematic assessments of the seismic capability of active faults with paleoseismological and geological methods are of particular importance for the sites Philippsburg (KKP, located within the Rhine Graben) and Neckarwestheim (GKN, located at about 45km distance from the Graben). The importance of paleoseismological assessments for the Rhine Graben area has been proved by recent research in both, the lower Rhine embayment (Camelbeek et al., 2007; Kübler et al., 2011) and the upper Rhine Graben (Meghraoui et al., 2005; Peters et al., 2001). The results of these investigations made clear that the historical and instrumental earthquake record is insufficient for describing the seismicity of the analysed faults. The hazard contribution of the "slow" faults of the Rheine Graben fault system therefore needs to consider paleoseismological and geological evidence. The importance of the updated approach has recently been documented by Vaneste et al. (2013). References: Camelbeeck, T., Vanneste, K., Alexandre, P., Verbeeck, K., Petermans, T., Rosset, P., Everaerts, Warnant, R., & van Camp, M. (2007). Relevance of active faulting and seismicity studies to assessments of long-term earthquake activity and maximum magnitude in intraplate northwest Europe, between the Lower Rhine Embayment and the North Sea: Geological Society of Ameria Special Paper 425: 193-224. Meghraoui, M., Delouis, B., Ferry, M., Giardini, D., Huggenberger, P., Spottke, I., & Granet, M. (2001). Active Normal Faulting in the Upper

	Rhine Graben and Paleoseismic Identification of the 1356 Basel Earthquake: Science, 293: 2070-2073. Kübler, S., Friedrich, A.M. & Strecker, M.R. (2011). Seismogenic surface faulting in the area of Germany's strongest historical earthquake, Lower Rhine Embayment, NW Germany, In: Breitkreuz, C., Gursky, H.J. (eds.): Geo-risk management – a German Latin American approach, Freiberger Forschungshefte, C538: 13-16. Peters, G., Buchmann, T., Connolly, P., van Balen, R.T., Wenzel, F. & Cloetingh, S. (2005). Interplay between tectonic, fluvial and erosional processes along the Western Border Fault of the northern Upper Rhine Graben, Germany: Tectonophysics, 406: 39-66. Vaneste, K., Vleminckx, B., Verbeeck, K & Camelbeek, T. (2013). Modeling seismic hazard in the Lower Rhine Graben using a fault-based source model. Geophysical Research Abstracts, 15: EGU2013-4707. http://meetingorganizer.copernicus.org/EGU2013/EGU2013-4707.pdf
To be discussed	Requested information should respond to the following questions: ➢ How do the German regulatory authorities assess the new data that are available for seismic hazard assessment in the Rhine Graben area? ➢ What is the schedule of PSRs and external hazard re-assessment for KKP and GKN? ➢ Are there any measures or programs envisaged to update the seismic hazard assessment for the sites near the Rhine Graben?
Safety importance	High
Safety priority	Medium term
Follow-up	Dedicated presentation

3.2 Topic 2: Loss of Safety Systems

Germany	
Topic 2: Loss of safety systems	
Issue No	**DE 2.1**
Title	Increase of availability and operability of emergency power supply (for those NPPs where such measure is not yet implemented)
Content	The issue addresses the installation of additional emergency power generators (EPG) and connection points protected against external hazards to extend the availability of AC and DC power supplies in case of station blackout. An installation of additional EPGs shall ensure: • The supply of vital I&C installations, SG emergency feeding, and battery support (KBR/ PWR, KKE/ PWR, KKG/ PWR, KKI-2/ PWR, KWG/ PWR. • The supply of the accident overview measuring systems and RPV feeding (KRB B+C/ BWR). For connection of emergency power generators, two physically separated connection points will be established, such that preferably one of these points will still be available in case of a beyond-design-basis event. The management of lubricants and other operating materials will be improved to ensure the reliable supply of diesel fuel in the event of a sustained loss of offsite power. The required tools and connection cables will be provided accordingly.
Safety relevance	In case of a station blackout, accident management measures have to be taken to re-establish the three-phase supply within 10 hours with an additional emergency power generator. The emergency power generator has to be capable of supplying all systems that are required for plant shutdown and keeping the plant in a stable subcritical state. During this period the heat removal from the reactor core and the fuel pool shall be ensured. The power supply required to support the long term availability of accumulator batteries as well as the power supply of the accident overview measuring systems and the necessary lighting have to be ensured as well. If additional operating agents and auxiliary equipment are required, their availability has also to be ensured.
Background	All German NPPs have at least three off-site electrical power supply possibilities: the main grid connection, the standby grid connection and the emergency grid connection. Each emergency power system of the German NPPs has at least four emergency diesel generators. Furthermore, in most NPPs a second emergency power system with up to four additional emergency diesel generators is available. If all these supply alternatives fail, the different plants have additionally a battery secured DC and AC power supply, which support, together with accident management measures, the removal of the residual heat. Also, in most NPPs a mobile diesel is available to recharge the batteries or to supply selected pumps/components. The national recommendations from the GRS Information Notice and from all RSK Recommendations relating to Fukushima, as listed in the German NAcP (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2012), include: • In the event of a station blackout, 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 overview measuring systems and the necessary lighting have to be ensured. • In the event of a station blackout, accident management measures have to be provided which secure that the three-phase supply can be re-established within 10 hours with the help of an additional emergency power generator. The emergency power generator has to be capable of supplying all systems that are required for plant shutdown and heat removal from the reactor core and the fuel pool. If additional operating agents and auxiliary equipment are required, their availability has also to be ensured. For connection of the emergency power generator, there have to be two physically separated connections points, such that preferably one of these points will still be available in case of a beyond-design-basis events. The emergency power generator has to be available also in case of a beyond-design-basis event, especially in case of earthquakes, flooding and damage to plant-internal and external infrastructure. The service fluids supply to the emergency power generator and to all essential systems has to be ensured accordingly, and all required tools and connection cables have to be kept ready. • It is to be demonstrated that the supply of three-phase alternating current required for the vital safety functions is ensured even if there is no grid connection available for up to a week. In the case of a station blackout, the vital safety functions have to be maintained or re-established in time before reaching “cliff-edge” effects (direct current supply if three-phase alternating current supply is not available for up to 10 hours, layout of standardised hook-up points protected against external hazards outside of the buildings, and a mobile emergency power generator protected against external hazards for at least one redundant residual heat removal train). In response to these recommendations the following actions are under implementation: • GKN II and KKP II have provided two mobile diesel generators at the site, operability was demonstrated in 2012 refuelling outage. At KKP II this provides also assurance of DC power supply for up to 10 hours. Technical description and procedures are available. Full completion of connections points and of the documentation is to be finalized in 2013. • KBR, KKG and KKI II have prepared a comprehensive and integrated concept for postulated SBO scenarios. Obtaining and providing a mobile emergency diesel generator for the supply of vital I&C installations, SG emergency feeding, and battery support, and for the supply in the long-term range of an emergency RHR chain, as well as measures and procedures to prolong the operating times of emergency diesel generators, using secured fuel stocks are to be finalized in 2013. • KKE planned to provide a mobile emergency power generator and connections points protected against external hazards, e.g., for the supply of the accident overview measuring systems, the SG emergency feeding system and the spent fuel cooling system, to be finalized in 2013. • KRB B+C planned to provide a mobile emergency power generator and connections points protected against external hazards for the supply of

	the accident overview measuring systems and for RPV feeding, to be completed in 2013. • KWG has prepared a comprehensive and integrated concept for postulated SBO scenarios and provided a mobile emergency diesel generator for the supply of vital I&C installations, SG emergency feeding, battery support, and for the supply in the long-term range of an emergency RHR chain in 2012. The establishment of connection points for connecting mobile emergency diesel generators with protection against external hazards and measures and procedures to prolong the operating times of emergency diesel generators, using secured fuel stocks are to be completed in 2013. • GKN I and KKP I planned to provide a statement on the maintenance of the electricity supply on the basis of a safety analysis, to be completed in 2013 • KKK is to provide different statements on dealing with the recommendations regarding SBO in 2013 References: Federal Ministry of Environment, Nature Conservation and Nuclear Safety (2011). EU Stresstest National Report Germany. http://www.ensreg.eu/node/360 Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2012). German Action Plan for the implementation of measures after the Fukushima Dai-ichi reactor accident. http://www.ensreg.eu/node/691
To be discussed	The presentation should describe in more detail the safety concept and design of the proposed measures, addressing the following questions: ➢ What is the progress to date, including regulatory review and approval? ➢ What connection configurations are envisaged? ➢ What are the technical characteristics of the additional equipment (DGs) and how are they protected against external hazards? ➢ Which consumers would they supply? ➢ What will be the safety margin gained? ➢ What measures and procedures are envisaged to prolong the operating times of emergency diesel generators, using secured fuel stocks?
Safety importance	High
Schedule	Short term
Follow-up	Dedicated presentation

Germany	
Topic 2: Loss of safety systems	
Issue No	**DE 2.2**
Title	Increase the capability of residual heat removal (KBR)
Content	Installation of a mobile pump, protected against external events, inside the emergency feed water building for feeding the steam generators for the accident management measure ‘secondary bleed and feed’[1].
Safety relevance	In case of SBO, when no AC power supply is available, all operational and safety-relevant systems for steam generator feeding are unavailable and thus the accident management measure ‘secondary bleed and feed’ will be applied. The objective of this measure is to depressurize the steam generators and to feed into the depressurized steam generators to ensure core cooling. To ensure the long-term heat removal from the core, feeding of at least one steam generator with a mobile pump is necessary.
Background	The complete failure of the independent bunkered 4 train emergency feedwater system is extremely unlikely. These systems are protected against aircraft crash, external explosion and earthquake. In this case, the heat removal via the steam generators to the atmosphere can be ensured by the accident management measure ‘secondary bleed and feed’. For depressurisation of the steam generators the pressure relief valves or the safety valves will be opened. Coolant will be injected from the feedwater storage tank and in the long run from different sources with mobile pumps. KBR planned to review and optimise if necessary the robustness of the ‘secondary bleed and feed’, to be completed in 2013. References: Federal Ministry of Environment, Nature Conservation and Nuclear Safety (2011). EU Stresstest National Report Germany. http://www.ensreg.eu/node/360 Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2012). German Action Plan for the implementation of measures after the Fukushima Dai-ichi reactor accident. http://www.ensreg.eu/node/691
To be discussed	The information of interest includes: ➢ Details on the installation (location, capacity, response time, water and power sources). ➢ The status of the completeness. ➢ The status of the update of the procedures including accident management to cover the operation of the mobile pump.

[1] In other countries termed ‘feed and bleed’; German reports terminology ‘secondary bleed and feed’ is kept in this report.

Safety importance	High
Schedule	Short term
Follow-up	Check list

Germany	
Topic 2: Loss of safety systems	
Issue No	**DE 2.3**
Title	Enhancement of SFP cooling (all NPPs in operation and recently shutdown)
Content	Additional emergency measures for external coolant injection into the spent fuel pool, with additional equipment as needed.
Safety relevance	External coolant injection into the SFP provides the additional option for the prevention of spent fuel damage in long term perspective. SFP cooling during prolonged SBO or loss of ultimate heat sink events is needed to remove spent fuel decay heat and prevent spent fuel damage. The decay heat can be removed by vaporisation of the spent fuel pool coolant and injection of water from different sources. If injection into the SFP is not provided, the water level in the SFP will drop, and eventually fuel damage will occur. The SFP area will become inaccessible due to radiation. This will impair further operator actions in the SFP area (e.g. to operate valves or to establish connections to mobile sources of coolant).
Background	The spent fuel pool cooling system has the task of cooling the spent fuel pool for all conditions of normal operation and design basis accidents. For this purpose in two of the four trains of the residual heat removal system a spent fuel cooling pump is integrated. In case of an accident these two lines of the spent fuel pool cooling system can also be used for residual heat removal from the reactor. In addition, a 3rd train for spent fuel pool cooling is installed, which is independent from the residual heat removal system. Older German PWRs (e.g. GKN-I, KWB-A+B) have corresponding spent fuel pool cooling systems with different engineering features. However, the situation at these plants as well as at the other shutdown NPPs is more favourable due to lower decay heat levels, as well as there might be a possibility to use the (reactor) RHR system, because due to an empty reactor (fuel removed) vessel, the RHR could be fully devoted to the SFP cooling. The national recommendations from the GRS Information Notice and from all RSK Recommendations relating to Fukushima, as listed in the German NAcP (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2012), include the following two, relevant for the SFP cooling: • 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. The system needs to be designed against erroneous operation or tripping. • Consideration of wet storage of fuel assemblies in the accident management concept, taking into account the following aspects: possibilities of injecting water into the spent fuel pool without the need to enter areas with high risk potential, and ensuring evaporation cooling, safety demonstrations for the fuel pool, reactor. In response to these recommendations the following actions are under implementation: • GKN II, KKP-2: The operability of measures for injecting into the spent-fuel pool was demonstrated during 2012 refuelling outage, technical

	description and procedures have been prepared. Further optimisation without accessing certain areas is to be completed in 2013 • KBR, KKG, KKI-2, KKE, KRB B+C, KWG, KWB A+B: Creation of a permanently installed injection path into the spent fuel pool that is accessible from outside the containment and preparation of comprehensive analyses and development of emergency measures regarding the loss of spent fuel pool cooling during BDBA to be completed in 2013 • GKN I, KKP-1: Measure for injecting into the spent fuel pool and operability was established in 2012. The regulatory authority is examining whether the safety-related objective of the recommendation has been reached by the measure, activity to be completed in 2013. • KKI-1, KKU: Development of procedures and measures for the prevention and mitigation of beyond-design-basis accidents in the area of the spent fuel pool. • KKK: Review of the instrumentation in the area of the spent fuel pool to be completed in 2013 References: Federal Ministry of Environment, Nature Conservation and Nuclear Safety (2011). EU Stresstest National Report Germany. http://www.ensreg.eu/node/360 Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2012). German Action Plan for the implementation of measures after the Fukushima Dai-ichi reactor accident. http://www.ensreg.eu/node/691
To be discussed	The information of interest includes: ➢ Details of the improvements of the SFP cooling at all plants where the compliance with the RSK recommendation has not yet been demonstrated. ➢ Safety gain by this measure, for operating plants and for shutdown plants. ➢ Status of the completeness of the implementation measures, including hardware, procedures and training, as needed.
Safety importance	Medium
Schedule	Medium term
Follow-up	Check list

3.3 Topic 3: Severe Accident Management

Germany	
Topic 3: Severe Accident Management	
Issue No	**DE 3.1**
Title	Availability of accident management measures in case of design basis natural hazards
Content	Before Fukushima, accident management measures have not been systematically analysed for their robustness in case of natural events. After the Fukushima accident, a systematic review of accident management measures and their effectiveness was initiated in Germany. In particular, limitations of accessibility and impairment of the operability of measures are considered. Special emphasis in this context is laid on filtered containment venting. The assessment covers a wide range of topics and is performed with a comparatively tight schedule. However, it is not entirely clear which concrete improvement measures will be the result of the investigations. Also, it is notable that the activities planned are not the same for all operating nuclear power plants.
Safety relevance	In case of a natural event, accident sequences can be initiated and the availability of accident management measures can be important to prevent or at least to mitigate radioactive releases. However, the same event can lead to restrictions and problems, like reducing the accessibility of the buildings at the NPP site as well as compromising the operability of AM measures and of remote shutdown and control stations. The Fukushima accident has illustrated this point. The Fukushima accident was a beyond design basis event. But even in case of a design basis natural event, there can be additional failures which are not foreseen and can lead to critical situations requiring accident management. Therefore, a systematic study of the availability of accident management measures in case of DB natural events is of vital importance, followed by the implementation of improvement measures which have been identified.
Background	In the National Stresstest Report (BMU 2011), it is stated that *[t]he estimation of factors which may limit the Accident Management provisions require additional analyses by an appropriate systematics* (section 6.5.2). A recommendation of RSK from May 2011 is referred to which addresses the same issue: *Review of the necessary scope of accident management measures and their effectiveness* (section 0.4.1). This was further pursued by RSK. In September 2012 RSK issued a Recommendation on the Robustness of German NPPs (RSK 2012b), as follow-up to first recommendations of May 2011. This recommendation is based on the results of the German and the EU stress tests (see also Issues DE 3.3 and 3.4). Among other issues, the RSK recommendation addresses the availability of accident management measures during or after design basis natural events. RSK states that the safety objectives of the accident management measures

	should be achieved during or after such events. In particular, RSK recommends to consider the following aspects (part 2, 1): • Limitations of the accessibility of the power plant area and buildings, • operability of the accident management measures, and • availability of the remote shutdown and control station. Filtered containment venting is separately addressed explicitly in the recommendation (part 2, 4): The filtered containment venting system has to be available during or after design basis natural events and in case of station blackout. In these cases, it must be possible to repeatedly perform the pressure relief. The effectiveness of installations to reduce hydrogen in the containment is to be ensured. No dates are given for the implementation of the recommendations by the RSK. These recommendations are also addressed in the National Action Plan (NAcP) (BMU 2012a); the first one in recommendation/suggestion N-18: *It should be clarified whether the safety objectives of the accident management measures can also be achieved during or after natural external design basis hazards. In particular, the following aspects should be considered: limitations of the accessibility of the power plant are and power plant buildings that may have to be postulated, operability of the accident management measures, and availability of the remote shutdown and control station.* The recommendation concerning filtered venting is taken up in recommendation/suggestion N-21: *The filtered containment venting system is to be designed so that pressure relief can also be repeatedly performed during or after natural external design basis hazards and in the event of a station blackout. Furthermore, the effectiveness of installations to reduce hydrogen in the containment is to be ensured accordingly.* The German NAcP also contains a plant-specific listing of measures to implement the general recommendations/suggestions. It is notable that the plant-specific sets of measures mostly are the same for plants belonging to the same owner (or majority owner). For RWE, KRB B+C is the only BWR still operating in Germany, and there are specific measures in this case. The year of finalisation is given in brackets. The following measures are relevant for recommendation/suggestion N-18: <u>1) KBR, KKG, KWG, KKI 2 (E.On):</u> • *Examination of the flooding-safe storage of safety-relevant equipment (2012 – in one case before 2012)* • *Review of the availability of the remote shutdown and control station (before 2012)* • *Review and optimisation if necessary of the robustness of the emergency measure "secondary bleed and feed“ (2013)* <u>2) GKN II, KKP 2 (EnBW):</u> • *For selected emergency procedures with special relevance (primary bleed, secondary bleed), assessment of the operability in the event of external design impacts (2012)* <u>3) KKE, KRB B+C (RWE):</u> KKE:

	• *Review of the availability of the remote shutdown and control station, if necessary re-location (2013/14)* KRB B+C: • *Introduction of new/optimisation of existing emergency measures (2012/13)* *- early opening of motorised pressure relief valves* *- increase of the possible pressure of RPV injection via mobile pumps* *- additional option of using fire engines as mobile pumps for RPV injection* *- early switch-off of individual diesel generators to conserve fuel supplies* *- quicker execution of the emergency measure for injecting into the spent fuel pool* • *Review of the availability of the remote shutdown and control station, if necessary re-location (2013/14)* The measures belonging to N-21 are: 1) KBR, KKG, KWG, KKI 2 (E.On): • *Review and optimisation if necessary of the requirements for the containment venting system with consideration of SBO and adverse radiological conditions (2013)* 2) GKN II, KKP 2 (EnBW): • *Possibility of venting without electricity supply has been demonstrated (2012)* • *Analysis of the accessibility of the installations upon manual operation under adverse radiological conditions and of long-term operation in progress (2013)* 3) KKE, KRB B+C (RWE): No measures listed. References: BMU (2011). Federal Ministry of Environment, Nature Conservation and Nuclear Safety. EU Stresstest National Report Germany. http://www.ensreg.eu/node/360 BMU (2012a). Federal Ministry of Environment, Nature Conservation and Nuclear Safety. German Action Plan for the implementation of measures after the Fukushima Dai-ichi reactor accident. http://www.ensreg.eu/node/691 RSK (2012b). Reaktor-Sicherheitskommission. Empfehlungen der RSK zur Robustheit der deutschen Kernkraftwerke. 450. Sitzung am 26./27.09.2012. (Also available in English translation.) http://www.rskonline.de/downloads/epanlage1rsk450homepage.pdf
To be discussed	Questions which should be discussed in a workshop are: ➢ Recommendation/suggestion N-18 mostly concerns examinations, reviews and assessments. They cover only a part of the accident management measures in case of a natural DB event. According to which criteria were these measures selected? Why is, for example, seismically safe storage of equipment not addressed? Why not

	reviewing other emergency measures? ➢ What are the results of the examinations, reviews and assessment concerning N-18? How will the results be evaluated? Are there any further backfitting measures planned on the basis of the results? If so, which measures, which schedule? ➢ For recommendation/suggestion N-21, the measures listed in the NAcP cover "review and optimisation" for SBO and adverse radiological conditions. N-21 further addresses the following aspects: Repeated performance of venting, venting available after natural DB events, considerations of hydrogen. Are these other aspects also covered by measures? If so, which measures are envisaged, and what is the time schedule for their implementation? If not, why not? ➢ The review of the availability of the remote shutdown and control station (belonging to N-18) is implemented before 2012 in the first group of NPPs, not mentioned in the 2nd group, and to be implemented 2013/14 in third. What is the reason for these differences? ➢ Why are there no measures connected to N-21 listed for KKE and KRB? ➢ Regarding the overall picture - how will safety be improved by the measures already implemented or firmly planned? How does the state of the NPPs before implementation compare with the state after implementation of the measures? Which safety improvements are expected from further measures, if any? The majority of the measures are to be implemented by 2013. Hence, the discussion could take place at an early date.
Safety importance	High
Expected schedule	Short term
Follow-up	Dedicated workshop

Germany	
Topic 3: Severe Accident Management	
Issue No	**DE 3.2**
Title	Measures to improve the reliability of the ultimate heat sink
Content	The reliability of the ultimate heat sink is an important issue the Fukushima accident called attention to. Measures to improve the reliability with regard to blockage of cooling water intakes and with regard to rare external hazards have been discussed in Germany, as well measures to control the loss of the ultimate heat sink. However, the concrete activities envisaged mostly focus on the blockage issue and do not appear to cover fully the other aspects mentioned above. Furthermore, it is notable that the activities planned are not the same for all operating NPPs. For some plants, no measures seem to be planned at all.
Safety relevance	Even if an NPP is shut down, heat has to be continually removed from the reactor core and the spent fuel pool and finally dissipated into the environment. If the decay heat removal is interrupted, it will eventually result in core/fuel damage. Hence, a high robustness and reliability of the heat removal to the ultimate heat sink(s) is of high importance for NPP safety, as has been demonstrated in the Fukushima accident. For the heat dissipation into the environment, technical systems and environmental conditions interact. Thus, environmental conditions (in particular, external hazards) have to be taken into account when considering robustness and reliability of the heat removal.
Background	In the National Stress test Report (BMU 2011), there is a reference to on-going work of the Reactor Safety Commission (RSK), analysing the necessity of further measures to increase the robustness of plants without an alternate ultimate heat sink. It is stated that measures will depend on the RSK recommendation (section 5.4.3). The RSK review is also mentioned in the Peer Review Country Report. In April 2012 RSK issued a Statement “Loss of the Ultimate Heat Sink” (RSK 2012a), as follow-up to first recommendations of May 2011. This statement is taking into account the results of the German and the EU stress tests. The statement contains 3 recommendations (section 9): 1. Measures to review and possibly improve the reliability of the ultimate heat sink with regard to blockage of cooling water intake 2. Measures to strengthen the reliability of the ultimate heat sink with regard to the occurrence of rare external hazards 3. Measures to control the loss of the ultimate heat sink Several aspects are listed for each recommendation which have to be considered, for example: For recommendation 1: Potential of blockage due to high pollution loads, failure of filters leading to entry of dirt into the cooling systems, ice formation in the receiving water, early reporting of relevant weather events etc. For recommendation 2: Blocking of cooling water or flooding of cooling water

	intake structures For recommendation 3: Control of loss of UHS with simultaneous loss of power for at least 7 days, under consideration of appropriate boundary conditions (e.g. failure of room and component cooling etc.) This recommendation is also addressed in the National Action Plan (NAcP) (BMU 2012a) in the recommendation/suggestion N-12 *Measures to review and, where required, improve the reliability of the ultimate heat sink with regard to blockage of the cooling water intake to strengthen the reliability of the ultimate heat sink with regard to the occurrence of rare external hazards and to control the loss of the ultimate heat sink.* It is noteworthy that this recommendation/suggestion only covers the first of the three RSK recommendations completely. As the recommendation/suggestion is formulated, the other two recommendations are covered only to the extent that the first is relevant for them, and not independently of the first. For example, flooding of cooling water intake structures or loss of UHS with simultaneous loss of power does not appear to be dealt with here. The German NAcP also contains a plant-specific listing of measures to implement the general recommendations/suggestions. It is notable that the plant-specific sets of measures mostly are the same for plants belonging to the same owner (or majority owner). The year of finalisation is given in brackets. The following measures are relevant for recommendation/suggestion N-12: 1) KBR, KKG, KWG, KKI 2 (E.On): • *Creation of a diverse source of cooling water (2012)* • *Assessment of the CCF potential for the loss of the circulating water return structures and derivation of measures if necessary (2012)* 2) GKN II, KKP 2 (EnBW): • *Statement on fuel cooling – diverse heat sink (2012)* • *Examination with regard to supplementary aspects (2013)* • *No CCF potential for the loss of the circulating water return structures was identified (2012)* • *Statement on the reliability of the primary UHS (2012)* 3) KKE, KRB B+C (RWE): No measures listed. References: BMU (2011). Federal Ministry of Environment, Nature Conservation and Nuclear Safety. EU Stresstest National Report Germany. http://www.ensreg.eu/node/360 BMU (2012a). Federal Ministry of Environment, Nature Conservation and Nuclear Safety. German Action Plan for the implementation of measures after the Fukushima Dai-ichi reactor accident. http://www.ensreg.eu/node/691

	RSK (2012a). Reaktor-Sicherheitskommission. RSK-Stellungnahme Ausfall der Primären Wärmesenke, 446. Sitzung am 05.04.2012. (Also available in English translation.) http://www.rskonline.de/downloads/epanlage1rsk450homepage.pdf
To be discussed	The following questions should be addressed in the requested presentation: ➢ To which extent does the recommendation/suggestion N-12 of the NAcP cover the three RSK recommendations from April 2012? If parts of this recommendation are not covered – why? Will they be taken into account in later measures? ➢ The plant-specific measures which resulted from recommendation/suggestion N-12 and are listed in the NAcP are different for different NPPs. What is the reason for this? Why are there no measures listed for KKE and KRB? ➢ Details regarding the individual plant-specific measures are listed in the NAcP. Do all German NPPs have an alternate heat sink available now? If not, how is an equivalent level of safety guaranteed at the plants without an alternate heat sink? ➢ Are there any further measures planned or on-going in this context? ➢ Regarding the overall picture - how will safety be improved by the measures already implemented or firmly planned? How does the state of the NPPs before implementation compare with the state after implementation of the measures? Which safety improvements are expected from further measures, if any? All measures are to be implemented by 2013 at the latest. Hence, the discussion could take place at an early date.
Safety importance	High
Expected schedule	Short term
Follow-up	Dedicated presentation

Germany	
Topic 3: Severe Accident Management	
Issue No	**DE 3.3**
Title	Accident management measures in case of an internal flooding of the annulus in the reactor building of German PWRs
Content	After the Fukushima accident, RSK considerations covered a wide scope of issues, among them the robustness of German NPPs in case of failure of active preventive measures. This included issues not directly related to Fukushima, for example the internal flooding of the annulus in PWRs. In particular, it is being investigated which measures are being impeded in case of a flooding level of 2 m in the annulus, and which measures will be reliably available in different operating phases (including shutdown). It is notable that measures appear to be planned only in four of the seven PWRs operating in Germany.
Safety relevance	The annulus contains a considerable amount of equipment vital for safety (e.g. pumps necessary for decay heat removal and cooling of safety system equipment, pumps for boron injection into the RCS, I&C components of the reactor protection system). In case of a flooding of these components the safety of the plant might be threatened by a loss of safety functions, potentially leading to a severe accident. The potential for flooding of the annulus has been limited due to certain design provisions like passive barriers for the essential service water system or a limitation of the possible amount of water that can drain to the annulus (e.g. from the spent fuel pool). However, in case of assumed multiple failures flooding of the annulus might occur.
Background	In the National Stresstest Report (BMU 2011), it is mentioned that RSK has identified a number of issues of special interest for further work. Among those issues are *[g]eneric aspects of "flooding of the annulus" in PWR plants* (section 0.4.2). In September 2012 RSK issued a Recommendation on the Robustness of German NPPs (RSK 2012b, see also Issues DE 3.1 and DE 3.4). This recommendation is based on the results of the German and the EU stress tests. Among various other topics, the issue of annulus flooding was addressed in this recommendation. According to RSK, it has to be shown for the German PWRs how cliff edge effects can be avoided in case of flooding of the reactor building outside the containment. The following issues should be explained or clarified: - Identification of the safety-relevant installations which are failing in case of a flooding level of 2 m at the lower annulus level. It is to be examined, in particular, which impacts flooding of transducers and other electrical and I&C equipment located in the annulus may have on residual heat removal and the boration of the primary coolant. It has to be shown whether measures may be impeded, prevented or triggered incorrectly. - Taking the above into consideration, it is to be specified what measures will be reliably available in the different operating phases under the

	boundary conditions of beyond design basis flooding of the annulus up to a flooding level of 2 m for the prevention of an impermissibly long loss of vital safety functions. In particular, it is to be shown by which measures: o Secondary-side heat removal and, moreover, shutdown into a cold unpressurized, subcritical state are ensured in the short term in case of beyond design basis flooding during power operation, and which installations are required for this and are available. o Cooling of the fuel pool can be ensured within the required time in case of beyond design basis flooding both during power operation and low-power and shutdown operation. o Replacement of the evaporated inventory can be achieved in the short and medium term in case of beyond design basis flooding during low-power and shutdown operation with a lowered level in the reactor coolant lines (for example, it has to be demonstrated that the accumulator injection system is reliably available and can be activated). Furthermore, it is to be shown how in operating phases, with flooded reactor pool, scenarios with water losses from the connected system (RPV - reactor well - fuel pool) into the annulus are prevented under all operating conditions of the spent fuel pool cooling and purification systems (including leakage caused by human errors or false triggering of reactor protection signals). Furthermore, it is to be shown that such scenarios can still be managed in case of failure of the precautionary measures provided. In the **National Action Plan** (BMU 2012a), recommendation N-16 states that the impacts of a beyond-design basis annulus flooding on safety-relevant installations should be clarified. Furthermore, it is to be specified which measures will be reliably available for the prevention of impermissible losses. The German NAcP contains a plant-specific listing of measures to implement the general recommendations/suggestions. It is notable that the plant-specific sets of measures concern only one group of PWR plants. The year of finalisation is given in brackets. The following measures are relevant for recommendation/suggestion N-16: <u>1) KBR, KKG, KWG, KKI 2 (E.On):</u> • *Systematic review of the robustness of the plant in the event of a beyond-design flooding of the annulus (objective guarantee of vital functions) (2013)* <u>2) GKN II, KKP 2 (EnBW):</u> No measures listed. <u>3) KKE (RWE):</u> No measures listed. (KRB B+C are SWRs and the measure does not apply to them.) References: BMU (2011). Federal Ministry of Environment, Nature Conservation and Nuclear Safety. EU Stresstest National Report Germany. http://www.ensreg.eu/node/360 BMU (2012a). Federal Ministry of Environment, Nature Conservation and

	Nuclear Safety. German Action Plan for the implementation of measures after the Fukushima Dai-ichi reactor accident. http://www.ensreg.eu/node/691 RSK (2012b). Reaktor-Sicherheitskommission. Empfehlungen der RSK zur Robustheit der deutschen Kernkraftwerke. 450. Sitzung am 26./27.09.2012. (Also available in English translation.) http://www.rskonline.de/downloads/epanlage1rsk450homepage.pdf
To be discussed	The following questions should be addressed in a presentation: ➢ The plant-specific measures which resulted from recommendation/suggestion N-16 and are listed in the NAcP concern only four of seven operating German PWRs. What is the reason for this? Why are no measures listed for GKN II, KKP 2 and KKE? ➢ Details regarding the individual plant-specific measures which are listed in the NAcP. What was covered by the systematic review of robustness? ➢ What were the consequences of the systematic review of robustness? Were any necessary backfitting-measures identified? ➢ Are there any further measures not mentioned in the NAcP planned or on-going in this context? ➢ Regarding the overall picture - how will safety be improved by the measures already implemented or firmly planned? How does the state of the NPPs before implementation compare with the state after implementation of the measures? Which safety improvements are expected from further measures, if any? All measures are to be implemented by 2013 at the latest. However, issues 3.1 and 3.2 are considered as more important and discussion of issue 3.3 could be scheduled at a later date.
Safety importance	High
Expected schedule	Medium term
Follow-up	Dedicated presentation

Germany	
Topic 3: Severe Accident Management	
Issue No	**DE 3.4**
Title	Development of AM measures in case of a load drop
Content	After the Fukushima accident, RSK considerations covered a wide scope of issues, among them the robustness of German NPPs in case of failure of active preventive measures. This included issues not directly related to Fukushima, for example the drop of a heavy load in the area of the primary system and the spent fuel pool. Failure of the cranes used for lifting spent fuel casks and other loads had not been considered before. In particular, drops into the spent fuel pool and the reactor pressure vessel are to be analysed, as well as drops in the vicinity of safety-related installations. It is not clear, however, for which of the operating German NPPs this measure is to be implemented.
Safety relevance	Drops of heavy loads are excluded from the design basis because of specific requirements applied to the equipment designated to handle these loads. However drops of heavy loads cannot be considered as practically eliminated. In case of a drop of heavy loads certain barriers or equipment important for safety might be damaged, including the reactor pressure boundary.
Background	In the National Stresstest Report (BMU 2011), it is mentioned that RSK has identified a number of issues of special interest for further work. Among those issues are *[i]-depth examination of precautionary measures to prevent load crashes in the area of the primary system and the fuel pool* (section 0.4.2). In September 2012 RSK issued a Recommendation on the Robustness of German NPPs, (RSK 2012b, see also Issues DE 3.1 and DE 3.3). This recommendation is based on the results of the German and the EU stress tests. Among various other topics, the issue of load drop was addressed in this recommendation. According to RSK, it has to be shown how cliff edge effects can be avoided in case of a drop of heavy loads. The following is recommended: - The impacts of the drop of a fuel element transport cask into the fuel pool should be analysed regarding the loss of pool water. It has to be checked whether it is possible to inject enough coolant to compensate a loss of fuel pool water, should it occur. Specific accident management measures should be introduced, if required. - Likewise, the impacts of the drop of loads into the RPV or onto the connection between RPV and fuel pool established during shutdown operation should be analysed. If necessary, specific accident management measures should be introduced in dependence on the consequential impacts. - Regarding the handling of loads in the vicinity of necessary safety-related installations, it should be analysed whether a postulated load drop leads to inadmissible repercussions on the reactor coolant pressure boundary, or to damages affecting more than one redundancy, that may lead to “cliff-edge” conditions in the plant. In the **National Action Plan** (BMU 2012a), recommendation N-17 states that *the*

	impacts of the drop of a fuel element transport cask into the fuel pool, the impacts of the drop of loads into the RPV or onto the connection between RPV and fuel pool established during low-power and shutdown operation and, where appropriate, inadmissible retroactive effects on the reactor coolant pressure boundary or damage affecting more than one redundancy should be analysed. It is noteworthy that in Table 4-2 of the NAcP (activities and measures in German NPPs), N-17 is mentioned for one NPP only (KKK, in post-operation, to be finalised 2013). It is not clear whether this measure will also be implemented in other plants – in particular, in the operating plants. References: BMU (2011). Federal Ministry of Environment, Nature Conservation and Nuclear Safety (2011). EU Stresstest National Report Germany. http://www.ensreg.eu/node/360 BMU (2012a). Federal Ministry of Environment, Nature Conservation and Nuclear Safety. German Action Plan for the implementation of measures after the Fukushima Dai-ichi reactor accident. http://www.ensreg.eu/node/691 RSK (2012b). Reaktor-Sicherheitskommission. Empfehlungen der RSK zur Robustheit der deutschen Kernkraftwerke. 450. Sitzung am 26./27.09.2012. (Also available in English translation.) http://www.rskonline.de/downloads/epanlage1rsk450homepage.pdf
To be discussed	The following questions should be addressed in a presentation: ➢ Why are there no activities listed in the NAcP for the operating NPPs? The recommended activity consists of analyses – why was it not regarded as necessary to perform these analyses? Is it regarded as very unlikely that the need for any improvement measures would be identified in the operating NPPs? ➢ Are there any activities not mentioned in the NAcP planned or on-going in this context? In the single plant concerned, the activities are to be completed by 2013 at the latest. However, since the safety importance of this issue is considered as medium, discussion could be scheduled at a later date.
Safety importance	Medium
Expected schedule	Long term
Follow-up	Dedicated presentation

Germany	
Topic 3: Severe Accident Management	
Issue No	**DE 3.5**
Title	Vulnerability of spent Fuel Pools at smaller BWRs of type SWR69 (permanently shut down) to airplane crash
Content	In the older German BWRs, the spent fuel pools are located outside the containment in the reactor building. For the three oldest plants of the type SWR69, there is hardly any protection against airplane crash. In case of airplane crash, cooling of the SFP could be lost; there could even be damage to the pool structure, leading to draining of coolant. The BWRs of type SWR 69 are permanently shut down. However, it will take several years until all spent fuel has been removed from the pools and transferred to the dry storage facility. The topic of vulnerability of the BWR 69 SFPs to airplane crash is not addressed in the available German stress test documents.
Safety relevance	Loss of cooling in the SFP leads to overheating if there are no counter-measures. Eventually, coolant will boil off, fuel elements reach a temperature at which zirconium-steam-interaction starts which accelerates further heat-up and produces hydrogen. However, since the fuel in the pools has already cooled down at least since spring 2011, overheating will be very slow and is not likely to constitute a problem. In case of damage to the pool itself, on the other hand, leading to draining of the coolant, a critical point can be reached much faster. This case is still relevant today.
Background	The spent fuel pools of the BWRs of type SWR69 are located outside the containment in the reactor building. For the smaller (and older) plants of this type, there is hardly any protection against airplane crash (wall thickness of about 30 cm in the upper part of the reactor building). This concerns Brunsbüttel, Isar-1 and Philippsburg-1. (For the bigger type 69 plant in Krümmel, protection is considerably better.) In case of airplane crash, cooling of the SFP could be lost; there could even be damage to the pool structure, leading to draining of coolant and exposure of the fuel elements in the short term. (Somewhat better protection is provided for fuel elements still in the reactor vessel.) The BWRs of type SWR 69 are permanently shut down. However, it will take several years until all spent fuel has been removed from the pools and transferred to the dry storage facility (storage in CASTOR casks). For example, for Isar-1, the removal and transfer will take until late 2015, at least. The topic of vulnerability of the BWR 69 SFPs to airplane crash is not addressed in the German documents related to the stress test and the 2nd CNS EOM. Although various aspects of the issue of heat removal from the SFP are addressed for the SWR 69 in the National Action Plan (BMU 2012a), the vulnerability to airplane crash (and other external hazards) is not dealt with. At the regular Bilateral Meeting in 2012 (BM A-DE 2012), the Austrian side had

	addressed this issue, pointing out that the vulnerability of SFPs to airplane crash had been one of the reasons for the decision to decommission the SWR 69s. It was enquired whether it was envisaged to transfer the spent fuel elements as fast as possible into dry storage to increase overall safety. The German side had replied that no safety reason was seen for accelerating the transfer of spent fuel elements from pools to dry storage. This point was not discussed in any detail. At the regular Bilateral Meeting in 2013 (BM A-DE 2013), the German side explained that in principle, all spent fuel elements which are still in the reactor building should be stored in on place. In most cases, this is the SFP. However, it was also said that in Brunsbüttel, the spent fuel is stored in the reactor vessel because of the better protection against AC, and better possibilities for coolant injection. It should be noted in this context that it is not a pre-condition for the granting of a decommissioning license that all fuel elements have been removed from the spent fuel pool. Thus, dismantling activities at a site can begin while there is still fuel in the pool. References: BM A-DE 2012. Discussion at the 18th German-Austrian Bilateral Nuclear Experts' Meeting, Vienna, June 04/05, 2012. BM A-DE 2013. Discussion at the 19th German-Austrian Bilateral Nuclear Experts' Meeting, Bonn, May 14/15, 2013. BMU (2012a). Federal Ministry of Environment, Nature Conservation and Nuclear Safety. German Action Plan for the implementation of measures after the Fukushima Dai-ichi reactor accident. http://www.ensreg.eu/node/691
To be discussed	The following question should be addressed in a presentation: ➢ What is the basis for the position that there is no need from a safety point of view to accelerate transfer of spent fuel from pool to dry storage? Which analyses and investigations have been performed to arrive at this position (scope, methods, results)? This issue has already been briefly discussed, without being fully clarified. A follow-up is therefore desirable. However, since the safety importance of this issue is considered as medium, discussion could be scheduled at a later date.
Safety importance	Medium
Expected schedule	Medium term
Follow-up	Dedicated presentation

Germany	
Topic 3: Severe Accident Management	
Issue No	**DE 3.6**
Title	Spent Fuel Pool at Gundremmingen NPP (KRB II)
Content	In the two newer German BWRs (type SWR72), the spent fuel pool is located in the reactor building, outside the primary containment. So far, no measures were implemented against hydrogen formation in case of a severe accident in the spent fuel pool, whereas the primary containment is partly inertized. Since the Fukushima accident, measures to deal with hydrogen releases occurring due to overheating of the spent fuel, in particular backfitting of recombiners, are planned.
Safety relevance	Emergency situations as happened in Fukushima might involve loss of cooling of the spent fuel elements within the spent fuel storage pool, thus leading to overheating and even subsequent melting of those fuel elements. From certain temperature levels on, heating is accelerated by zirconium-steam-interaction producing heat and hydrogen. The pool can contain considerably more spent fuel than a reactor core; accordingly, the amounts of hydrogen generated can be very large. This hydrogen might endanger the integrity of the surrounding building (the reactor building) if there are no hydrogen reduction systems, and significant releases of radioactive substances can occur. Thus, installation of recombiners with adequate capacity for the possible hydrogen source terms constitutes an important safety improvement.
Background	The spent fuel pool is used for storage of spent fuel elements until radioactivity has sufficiently decayed to permit inserting into casks for dry storage. In the two German BWR reactors of type SWR72, both located at Gundremmingen site, the spent fuel pool is located outside the primary containment. (The pool is located in the reactor building, which is also called “secondary containment”; this building provides protection against external events.) All other operating German NPPs are PWRs, with the spent fuel pool inside the containment. Since Fukushima, mitigating measures to deal with hydrogen release occurring in situations with overheating of fuel elements are under consideration. Such measures are mentioned in the Peer Review Country Report (ENSREG 2012) as having been recommended by RSK (section 4.2.4.1). They are not listed in the German Report to the 2nd CNS EOM, and they are also not addressed in the RSK recommendation of September 2012 (see Issues 3.1, 3.3 and 3.4), nor are they covered by another recent RSK recommendation. The National Action Plan (BMU 2012a), however, contains the measure of backfitting of H_2 recombiners in the area of the SFP of KRB B+C, finalised by 2013/2014 (p. 30). This corresponds to the general recommendation N-7 which is of relevance for KRB only. References: BMU (2012a). Federal Ministry of Environment, Nature Conservation and Nuclear Safety. German Action Plan for the implementation of measures after the Fukushima Dai-ichi reactor accident.

	http://www.ensreg.eu/node/691 ENSREG (2012). Peer review country report – Germany. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/sites/default/files/Country%20Report%20DE%20Final.pdf
To be discussed	The following questions should be addressed in a presentation: ➢ Has the implementation of these measures been completed according to schedule? ➢ Which accident scenarios, which hydrogen source terms were considered as basis for the planning this measure? An appropriate time to discuss this Issue would be after completion of implementation, as presently planned.
Safety importance	Medium
Expected schedule	Medium term
Follow-up	Dedicated presentation

3.4 Topic X: Outside Topics 1 - 3

Germany	
Outside topics 1-3	
Issue No	**DE X.1**
Title	Seismic design of residual heat removal and emergency core cooling system at Gundremmingen NPP (KRB II)
Content	The residual heat removal and emergency core cooling system at Gundremmingen NPP consists of three trains, only two of which are designed to withstand the design basis earthquake. This is in contradiction to the new German safety requirements for NPPs. The situation is ameliorated by the existence of an additional system for heat removal which provides one more train, designed for the DBE. On the other hand, the dedicated spent fuel pool cooling system is not designed for the DBE; SFP cooling relies on one of the seismically qualified trains of the residual heat removal system in case of a DBE. It is not clear on the basis of which considerations and analyses this situation has been judged acceptable by the licensing authority. However, it is planned to further pursue this issue in Germany.
Safety relevance	Because one safety train of the RHR and ECC system is not designed against the DBE, the redundancy of core cooling is reduced in case of DBE, compared to the requirements in the new SiAnf. The situation is aggravated by the fact that no dedicated systems for SFP cooling are not available in this situation and one train of the RHR and ECC system is required for SFP cooling. The expected frequency of core or spent fuel damage in case of DBE is potentially larger than it would be in the case of all trains being designed against DBE.
Background	According to the Licensee Report for Gundremmingen (KRB II 2011, section 2.1.2.1), the residual heat removal and emergency core cooling system is designed with 3x100% redundancy in each unit. Two trains are designed to withstand the design basis earthquake (DBE; Bemessungserdbeben), the third is not. There is an additional system for residual heat removal and injection (AHRS, or ZUNA in German) with 1x100%, which is also designed against DBE. It is argued in the Licensee Report that, with ZUNA, there is still a redundancy of 3x100% in case of DBE, being able to accommodate a single failure plus repair case. According to BMU, ZUNA cannot be assigned to a safety level, because it has been constructed before the system of safety levels as used today has been defined (DBT 2013a). However, it could be argued that it belongs to safety level 4 and hence should not be taken credit of in case of DBE, which is part of safety level 3. In any case, it is not clear from published information whether ZUNA is fully qualified as safety system , and hence could be fully credited at safety level 3, or not. The lack of seismic design against DBE in one train appears to be connected to the backfitting of an intermediate cooling system in 1991 (DBT 2013c). According to the new “Safety Requirements for Nuclear Power Plants” (Sicherheitsanforderungen an Kernkraftwerke, SiAnf) from November 2012

	(BMU 2012b), all safety systems have to be designed to ensure that they can fulfil their safety tasks also in case of external events (section 2.4). Although it is not stated explicitly, it has to be assumed that this refers to design basis external events. The German Ministry for the Environment (BMU) confirmed that one of the safety trains at Gundremmingen does not fulfil this requirement. However, it is also pointed out that ZUNA provides an additional train designed for the DBE and thus, the number of available trains is regarded as sufficient. BMU also emphasizes that the Länder authorities are responsible for the application of the new SiAnf in each individual case (DBT 2012, 2013b). From today's perspective it appears impossible to determine why one train of the RHR/ECC system has not been designed against the DBE (DBT 2013c). It should be noted that according to the Licensee Report for Gundremmingen (section 2.1.2.1), the two cooling trains for the spent fuel pool are not seismically qualified to resist the DBE. In case of earthquake, the SFP has to be cooled by one of the two trains of the RHR and ECC system which are seismically qualified. In summary, in case of DBE, there are 3x100% trains available for cooling the reactor (including ZUNA). At the same time, 2 of those are available for cooling the SFP, of which one is required. One train of the RHR and ECC system does not fulfil the new German safety requirements. If two trains of the RHR and ECC system are not available (for example because of maintenance work), the plant may be operated for up to ten hours, according to the operating manual (Betriebshandbuch, BHB). In such a case, it was not taken into account so far whether the remaining operable train was designed for DBE, or not. If one train is not available, regardless which one, the plant may be operated for up to seven days. The new "Safety Requirements for Nuclear Power Plants" contain no rules for the case that although a system has sufficient redundancy, one of the trains is not designed against DBE. BMU and the responsible Länder authority (Bavarian StMUG) discussed this matter in January 2013. StMUG announced the intention to pursue the question of the design of the RHR and ECC system in the light of the new "Safety Requirements for Nuclear Power Plants", including the rules concerning non-availability of trains of the ECCS. There is no definite deadline for the conclusion of this process (DBT 2013c). This issue is not dealt with in other stresstest documents, apart from the Licensee Report, and it appears that there are no analyses or other measures planned in this context. References: BMU (2012b). Federal Ministry of Environment, Nature Conservation and Nuclear Safety. Sicherheitsanforderungen an Kernkraftwerke, 22. November 2012. http://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Atomenergie/Sicherheitsanforderungen_Kernkraftwerke-bf.pdf DBT (2012). Deutscher Bundestag, 17. Wahlperiode. Antwort der Bundesregierung auf die Kleine Anfrage zum kerntechnischen

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To be discussed	The following questions should be addressed in a presentation: ➢ Is ZUNA fully qualified as a safety system of level 3? If so, what is lacking to achieve such qualification? ➢ What is the reason that the licensing authority has accepted the situation at KRB, regarding seismic design of the residual heat removal and emergency core cooling system, as well as the fuel pool cooling system, until today? Which analyses, which considerations were performed by the licensing authority to assess this situation? ➢ Results of the review of the requirements concerning non-availability of trains of the HR and ECCS by the authority? ➢ Are there plans for backfitting? If yes, what is planned? ➢ If not, which criteria were applied in the decision that the safety level is sufficient with the present design, in spite of the fact that the safety requirements (SiAnf) are not fulfilled? ➢ Are there plans for changing procedures (in particular, regarding the 10-hr-rule in case of availability of only one train of the RHR and ECCS? If not, how is this justified? Since it is not clear whether any analyses or other measures have been performed or are on-going or planned in this context, an early date for discussion would appear appropriate. However, it should be taken into account that there are other issues of higher safety importance.
Safety importance	Medium
Expected schedule	Medium term
Follow-up	Dedicated presentation