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Stress test Follow-Up Actions

Issue Paper for the Czech Republic

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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, the Melk-process follow-up and other previous discussions. The results of the analysis for the Czech Republic 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
- Topic #X: Issues of the Melk-process follow-up

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, Czech Republic				
Issue	Title	Safety importance	Follow-up	
			Action	Schedule
TOPIC 1: Initiating Events				
CZ 1.1	Modifications of the legal requirements for earthquakes, flooding and extreme weather	Medium	Check list	4Q/2015
CZ 1.2	Seismic upgrade to 0.10g PGAH, NPP Dukovany	High	Dedicated presentation	4Q/2015
CZ 1.3	Qualification of safety-classified SSCs and seismic margins, NPP Dukovany	High	Dedicated presentation	4Q/2015
CZ 1.4	Resistance of cooling towers against earthquake and storm, NPP Dukovany	High	Dedicated presentation	4Q/2014
CZ 1.5	Upgrading of civil structures including fire brigade buildings, NPPs Dukovany and Temelín	Medium	Check list	4Q/2015
CZ 1.6	Extreme weather: Hazard assessment, design bases and safety margins, NPP Dukovany	High	Dedicated workshop	4Q/2016
CZ 1.7	Seismic hazard assessment, NPP Temelín	High	Dedicated workshop together with CZ 1.8	4Q/2014
CZ 1.8	Seismic hazard assessment, NPP Dukovany	High	Dedicated workshop together with CZ 1.7	4Q/2014
TOPIC 2: Loss of Safety Systems				
CZ 2.1	Enhancement of heat removal from the RCS and SFP, NPPs Dukovany and Temelín	High	Check list	4Q/2014
CZ 2.2	Backup power supply for operation of communication equipment on site, NPPs Dukovany	Medium	Check list	4Q/2014
CZ 2.3	Alternative means for cooling of I&C equipment, NPPs Dukovany and Temelín	Medium	Check list	4Q/2016
CZ 2.4	Alternative AC power supply, NPPs Dukovany and Temelín	High	Dedicated workshop together with CZ 2.6	1Q/2015
CZ 2.5	Reliability of the containment isolation (valves), NPP Temelín	Medium	Check list	4Q/2014
CZ 2.6	Enhance the availability of the accumulator batteries, NPPs Dukovany and Temelín	High	Dedicated workshop together with CZ 2.4	1Q/2015
CZ 2.7	Extension of alternative cooling through the SG, NPP Dukovany (NAcP Action 17)	High	Dedicated presentation	4Q/2017
CZ 2.8	Increase of ability to control the key parameters at the post-accident phase, NPP Dukovany (NAcP Action 27)	High	Dedicated presentation	4Q/2017
TOPIC 3: Severe Accident Management				
CZ/HU/SK 3.1	Stabilization of molten core of reactors of type VVER 440/213 (Bohunice, Dukovany, Mochovce, Paks)	High	Dedicated workshop[1]	1Q/2016
CZ 3.2	Filtered containment venting at NPP Temelín	High	Dedicated presentation	4Q/2016
CZ 3.3	Hydrogen management by passive autocatalytic recombiners for NPPs Temelín and Dukovany	High	Dedicated presentation	4Q/2015
CZ 3.4	Stabilization of molten core for NPP Temelín	High	Dedicated presentation	4Q/2015
CZ 3.5	Common VVER emergency support centre	Medium	Dedicated presentation	4Q/2017
CZ 3.6	Upgrade of PSA level 2, NPPs Dukovany and Temelín	Medium	Dedicated presentation	4Q/2018
TOPIC X: Outside Topics 1 - 3				
CZ X.1	High energy pipelines of the secondary circuit at NPP Temelín	High	Dedicated presentation	4Q/2014
CZ X.2	Reactor pressure vessel integrity at NPP Temelín	Medium	Dedicated presentation	4Q/2016

[1] For this Issue, a quadri-lateral workshop (between Czech Republic, Hungary, Slovakia and Austria) would be preferable. In case the Issue will be discussed in a bilateral framework, the questions will be revised to refer more specifically to what is relevant for each particular country.

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

Czech Republic	
Topic 1: Initiating events	
Issue No	**CZ 1.1**
Title	Modifications of the legal requirements for earthquakes, flooding and extreme weather
Content	Specific requirements for nuclear facilities with respect to external risks are described in Regulation No. 195/1999 Coll. of SÚJB (Requirements on Nuclear Installations for the Assurance of Nuclear Safety, Radiation Protection and Emergency Preparedness). The regulation refers to natural events such as earthquakes, windstorms and floods stating that: "The most severe natural phenomena or events that have been historically reported for the site and its surroundings, extrapolated with a sufficient margin for the limited accuracy (uncertainties) in values and in time" need to be considered for the design of nuclear installations. This regulation differs from international and EU practice, which is to derive design base values for natural hazards from events expected at significantly lower occurrence probabilities (commonly 10^{-4} per year).
Safety relevance	The current safety regulations for the Czech Republic do not conform to international standards and practice. SUJB (2011), however, claims that design bases are derived from events with exceedance probabilities of less than 10^{-4} per year.
Background	As one of the outcomes of the Stress Tests ENSREG (2012) suggests using 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. References: ENSREG (2012). Compilation of recommendations and suggestions. Peer review of stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/512 SÚJB (2011). National Report on "Stress Tests" NPP Dukovany and NPP Temelin Czech Republic. Evaluation of Safety and Safety Margins in the Light of the Accident of the NPP Fukushima. http://www.ensreg.eu/node/369
To be discussed	Confirmation of implementation of measure. No further information required.
Safety importance	Medium
Expected schedule	Medium term
Follow-up	Check list

Czech Republic	
Topic 1: Initiating events	
Issue No	**CZ 1.2**
Title	Seismic upgrade to 0.10g PGAH, NPP Dukovany
Content	The original level of the design basis earthquake for the NPP Dukovany is given as a peak ground acceleration PGAH (peak horizontal ground acceleration) = 0.06g for the safety level SL2 (10.000 years recurrence interval, 95% non-exceedance probability). The original Seismic Hazard Assessment (SHA) was performed in 1985. In order to meet the minimum seismic design requirements suggested by IAEA, the level has been set to 0.10g PGAH (peak horizontal ground acceleration) and 0.067g PGAV (peak vertical ground acceleration) in 1995. Although the site went through a PSR in 2006/2007 and license extension was granted by the Czech regulator, upgrading to IAEA's minimum of 0.10g has not yet been completed.
Safety relevance	With respect to the low seismic resistance of NPP Dukovany retrofitting to the international minimum standards is regarded as highly safety relevant.
Background	The decision to upscale the seismic design basis of the NPP Dukovany from of 0.06g to 0.10g, which is suggested as minimum design level by IAEA (1991; 2010), was made in 1995 following an IAEA mission to the site. Information obtained from ČEZ (2012) during the Stress Tests Country Visit showed that a large part of the retrofitting actions had been completed by that time. However, some significant projects and design solutions were still pending. ČEZ informed that the last upgrades should be finalized in 2015. References: ČEZ (2012). Topics for Country Review Status of Upgrading of Dukovany to 0.1g DBE. Presentation at the ENSREG Stress Tests Country Visit, 26.-29.03.2012. IAEA (1991). Earthquakes and Associated Topics in Relation to Nuclear Power Plant Siting (Revision 1). Safety Guide 50-SG-S1, Vienna 1991. 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
To be discussed	The following information on the upgrading program is requested: ➢ Which SSCs and civil structures that have been identified for seismic upgrading? ➢ What are the most important retrofitting actions that became necessary? ➢ What is the current status of the retrofitting program? Which projects have been completed, and what is the time schedule for the completion of the remaining actions?
Safety importance	High
Expected schedule	Medium term
Follow-up	Dedicated presentation

Czech Republic	
Topic 1: Initiating events	
Issue No	**CZ 1.3**
Title	Qualification of safety-classified SSCs and seismic margins, NPPs Dukovany
Content	For the NPP Dukovany systems, structures and components (SSCs) and civil structures relevant for seismic resistance (classified to category "S") have been assessed by "type tests, calculations or indirect evaluation on the basis of operational experience". Resilience of the spent fuel pools, containment and civil structures on the containment boundary are assessed as follows: "After full completion of the design regarding the Dukovany NPP seismic upgrading, the basic safety functions will be preserved up to the level of the ground acceleration (PGAH) of 0.10g". The Stress Tests documents do not provide details about testing methods and the estimated robustness of the classified SSCs and civil structures.
Safety relevance	At the background of the very low safety margins obtained for some SSCs with respect to the upgraded design basis of 0.10g it should be demonstrated that seismic resistance of safety relevant SSCs has been assessed with reliable and conservative methods. ENSREG (2012a) recommends 0.1g minimum peak ground acceleration as a minimum for back-fitting with respect to seismic safety cases.
Background	The NPP Dukovany currently undergoes an upgrading process to increase the seismic resistance of safety classified civil structures and equipment from 0.06g (initial design intent) to 0.1g. In the seismic margin assessment SÚJB claims that the seismic safety margin is defined by the difference between the hazard level originally determined for the site (1985, PGAH=0.06g) and the level of seismic upgrading (PGAH=0.1g). Seismic margins of the basic safety functions of the NPP Dukovany have not been quantified systematically in the Stress Tests documents. SÚJB (2011) lists those civil structures and SSCs, which are classified into seismic categories (categories "Sa" to "Sc") without providing numerical values of their robustness or resilience. Quantitative data on margins is only available for some specific functions such as the circulation cooling water. For this an upper resistance limit is given as 0.112g being limited by the seismic capability of the cooling towers (SÚJB, 2011; ENSREG, 2012). With respect to the overall assessment of the seismic margins of the plant the Stress Tests Country Report states that events "of the intensity > 7° MSK-64 (PGAH > 0.1g) might cause loss of the NPP safety function" even after the completion of the upgrading program (SÚJB, 2011, p. 77). This indicates that the available safety margins might be small and no significant margins exist above 0.1g. ENSREG (2012b) states that systems, structures and components and civil structures relevant for seismic resistance were assessed by type tests, calculations or indirect evaluation based on operational experience. No further details about testing methods and the estimated robustness of the classified SSC and civil structures are provided.

	References: ENSREG (2012a). Czech Republic. Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/393 ENSREG (2012b). Compilation of recommendations and suggestions. Peer review of stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/512 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 SÚJB (2011). National Report on "Stress Tests" NPP Dukovany and NPP Temelin Czech Republic. Evaluation of Safety and Safety Margins in the Light of the Accident of the NPP Fukushima. http://www.ensreg.eu/node/369
To be discussed	The requested information should address the following questions: ➢ What methodologies have been used to assess the resistance of seismically classified SSCs and civil structures? ➢ What are the results of these assessments, and how large are the uncertainties of the estimated robustness? ➢ In particular: what methodology used to derive the value of 0.112g as the seismic margins for earthquake loads of the cooling towers and the uncertainties related to that value? ➢ Which SSCs or civil structures (apart from the cooling towers) limit the plant's safety margin? ➢ ENSREG (2012) mentions that at the time of the Stress Tests some activities were ongoing or planned to evaluate possible seismic margins above 0.1g. What are the status and results of these activities?
Safety importance	High
Expected schedule	Medium term
Follow-up	Dedicated presentation

Czech Republic	
Topic 1: Initiating events	
Issue No	**CZ 1.4**
Title	Resistance of cooling towers against earthquake and storm, NPP Dukovany
Content	During the Stress Tests information was provided that safety margins for some of the civil structures of the NPP Dukovany range from 0.112g for cooling towers to 0.19g for the vent stack. During the plant visit it was further explained that SSCs of safety classified systems reach resistance values between 0,11g and 0,169g. The upper resistance limits for circulation cooling water is given as 0.112g, based on the restricted capability of the cooling towers. Even tighter limitations of the resistance of cooling towers apply to wind loads. The low capability of the cooling towers to resist earthquake loads apparently limits the plants safety margins to 0.11g as no alternate heat sink is available at the site.
Safety relevance	The ultimate heat sink for NPP Dukovany is the atmosphere via the cooling towers. The cooling towers are not qualified as safety components. Secondary feed & bleed is proposed as alternative heat sink (i.e., pumping water from fire trucks into steam generators via the so called super emergency feedwater system, evaporating in the secondary side of steam generators, and release steam into the atmosphere). The very low safety margins obtained for the cooling towers with respect to earthquake loads led ENSREG (2012) to conclude that “SÚJB should consider ensuring enhanced capability for the cooling function”.
Background	The two units of Dukovany NPP are cooled by four wet cooling towers each, which serve as heat sink for both, service and essential service water systems. The cooling towers are not qualified as safety components. The resistance of the cooling towers against earthquake loads has been estimated with 0.112g in SÚJB (2011). SÚJB (2011, p. 77) further states that “the value of 0.112g, which is the boundary cooling tower resistance, can be conservatively called the deterministic limit value of seismic event intensity, the exceeding of which could cause core damage.” The external actions foreseen to prevent fuel degradation in case of a loss of the primary ultimate heat sink and the alternate heat sink are outlined in the Stress Tests documents (SÚJB, 2011; ENSREG, 2012). It is explained that upon the unavailability of the cooling towers an alternative heat sink can be established by pumping water from fire trucks into the steam generators via a so-called super emergency feedwater system (ENSREG, 2012). This water is to be evaporated in the secondary side of the steam generator and then released into the atmosphere. The process is referred to as “secondary feed & bleed”. It is further stated that this process is not adapted for ensuring alternative methods of heat removal from other essential service water system consumer appliances (e.g., the emergency diesel generators). The connections to inject water from fire brigade equipment (so-called hook up points) have been installed at Dukovany NPP. According to the information received during the Stress tests the available three fire trucks, which can be used to feed the steam generators, should be supplemented by an additional one to be able to serve each of the four units with at least one truck (ENSREG,

	2012). ENSREG (2012) states that the estimated time, which is available to recover a lost heat sink or to initiate external actions and restore core cooling before fuel damage is more than 10 hours. Although ENSREG (2012) concedes that there is redundancy and diversity in the cooling capabilities to ensure safety functions, it notes that an additional alternate heat sink has not been implemented in Dukovany NPP. It is consequently suggested that SUJB should follow up the diversification of the ultimate heat sink in Dukovany. ENSREG (2012) further suggests a number of possible measures to increase robustness of the ultimate heat sink including: ➢ Specific possible safety improvements for Dukovany NPP related to the loss of ultimate heat sink: Implement diverse (to the cooling tower) ultimate heat sink means. ➢ Develop a procedure for the loss of the ultimate heat sink and essential service water systems in all four units of the NPP. ➢ Develop a procedure for the refilling of steam generators using fire fighting equipment. ➢ Filling an open reactor and spent fuel pool by gravity drainage from bubbler trays. ➢ Extensive damage mitigation guidelines for the use of alternative means. These suggestions are at least partly considered by SÚJB (2012), e.g., by measure 33 “Implementation of ventilator cooling towers for ensuring independent ultimate heat sink”. At the Bilateral Meeting ČEZ (2013) provided first information about some details and time schedules for implementing two additional ESW fan cooling towers. References: ČEZ (2013). Nuclear Power Plants Status. Information provided during the discussions at the 22nd Czech-Austrian Bilateral Meeting, Langenlois, October 21/22 ENSREG (2012). Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/393 SÚJB (2011). National Report on “Stress Tests” NPP Dukovany and NPP Temelin Czech Republic. Evaluation of Safety and Safety Margins in the Light of the Accident of the NPP Fukushima. http://www.ensreg.eu/node/369 SÚJB (2012). Post Fukushima National Action Plan (NAcP) on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic. http://www.ensreg.eu/node/695

To be discussed	The Project Team request discussion and information on the following issues: ➢ An in-depth discussion of cooling by feed & bleed. It should be clarified whether the process is capable for ensuring heat removal from all essential service water system consumer appliances or not. It should further be clarified that the amount of water, the flow rate, and the injection pressure that can be sustained by the fire brigades is sufficient for cooling the reactor core and other consumers. ➢ Cooling by the feed & bleed procedure claims the full availability of the fire fighting equipment, which, however, is not safety qualified. SÚJB (2011) identified that the seismic resistance of the fire brigade buildings currently does not meet the SL2 level of 0.10g PGAH (see also Issue CZ 1.5). The seismic margin of the feed & bleed cooling procedure therefore appears to be even lower than the seismic resistance of the cooling towers. It should be clarified whether there is any success path that ensures reactor cooling after a possible loss of the cooling towers that exclusively relies on safety-classified and seismically qualified SSCs. ➢ Information on the safety classification and the robustness of the new ESW fan cooling towers with respect to earthquake and extreme weather. ➢ A more detailed explanation of how the actions listed in the National Action Plan (issues 13, 15, 17, 33 and 73) cover the suggestions by ENSREG (2012).
Safety importance	High
Expected schedule	Short term
Follow-up	Dedicated presentation

Czech Republic	
Topic 1: Initiating events	
Issue No	**CZ 1.5**
Title	Upgrading of civil structures including fire brigade buildings, NPPs Dukovany and Temelín
Content	SÚJB (2011) identified that fire brigade buildings along with other civil structures are not classified as safety relevant. The seismic resistance of the fire brigade buildings at both, NPP Temelín and Dukovany, currently do not meet the SL2 level of 0.15g and 0.10g PGAH, respectively. Measures to mitigate the impact of earthquakes as described in the Country Report (SÚJB, 2011: "Considering the fact that occurrence of seismic event is not sudden … the fire equipment can be moved to open spaces in time") appear insufficient. The low seismic resilience of some civil structures may limit site accessibility after an earthquake. The consequences of such limitations have not been fully explored.
Safety relevance	The civil structures of the fire brigade should ensure the functionality of the fire brigades after a seismic event. The topic appears important as the fire brigades should provide alternate measures for reactor cooling (pumping water to steam generators etc.) for both NPPs.
Safety importance	Medium
Background	The very low seismic resistance of the fire brigade buildings have been identified during the Stress Tests (SÚJB, 2011; ENSREG, 2012). As a first measure storages of essential equipment in tents outside the fire brigade buildings have been implemented. These facilities have been shown during the Stress Tests Country Visits. References: ENSREG (2012). Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/393 SÚJB (2011). National Report on "Stress Tests" NPP Dukovany and NPP Temelin Czech Republic. Evaluation of Safety and Safety Margins in the Light of the Accident of the NPP Fukushima. http://www.ensreg.eu/node/369
To be discussed	Confirmation of implementation of measure, status of interim solution (storage in tents). No further information required.
Safety importance	Medium
Expected schedule	Medium term
Follow-up	Check list

Czech Republic	
Topic 1: Initiating events	
Issue No	**CZ 1.6**
Title	Extreme weather: Hazard assessment, design bases and safety margins, NPP Dukovany
Content	The original design of NPP Dukovany followed the Czech standards for common buildings. National requirements specific for nuclear installations were not available at the time of NPP construction. Several re-assessments of meteorological hazards and the robustness of civil structures show that some basic safety functions of the NPP are endangered by extreme wind and snow, and that the resistance of some safety-relevant structures is lower than the loads expected for the design basis events (see below). The Stress Tests process consequently identified several safety relevant issues which may arise from extreme weather conditions (ENSREG, 2012): (1) Cooling towers at Dukovany have a limited capability in respect of strong wind; the PSR identifies the need to consider diverse ultimate heat sink possibilities. (2) Considerations for extreme snow loads show low or no margin for the generator halls, which might endanger the operability of the essential service water system. (3) Considerations for extreme low temperatures should be elaborated as some possible secondary effects (e.g., station blackout, availability of cooling water) are not included in the current assessments. (4) Procedures for special handling of extreme meteorological conditions should be elaborated and specific emergency management procedures should be added, including organizational arrangements to ensure the necessary staff in case of long-lasting extreme weather conditions.
Safety relevance	The robustness of some essential safety systems and civil structures such as the cooling towers of NPP Dukovany and the roof of the turbine hall does not meet the requirements of the design bases for extreme wind and snow load. The ENSREG National Report suggested several actions to ensure plants resilience against heavy weather conditions.
Background	The original design of NPP Dukovany against extreme weather considered the ČSN standards for common buildings. A design basis specific for NPPs has originally not been established. The design parameters for extreme weather have been assessed in 2000. This assessment is based on site-specific meteorological data covering 30 years. SÚJB (2011) states that the meteorological parameters (rain, wind, snow and max/min temperatures) for 100 and 10,000 years were determined according to the IAEA guidance using Gumbel statistics. The 100 year extreme values are consequently regarded as “design basis” parameters, while the 10.000 year values are referred to as “extreme design basis load”. The values determined for the 100 years recurrence interval serve as design basis for non safety classified SSCs, the values obtained for 10,000 years for safety classified SSCs. Load assessments for ***high winds*** were updated by a probabilistic study in 2008. This assessment apparently revealed that wind loads need to be expected,

	which are significantly higher than those used in the “design basis” and “extreme design basis load” (SÚJB, 2011). A subsequent evaluation of the safety margins against high winds was performed during 2009-2010. The results show that for some civil structures the maximum load capacities are lower than the loads that correspond to gust wind of the 10,000 years recurrence interval. According to SÚJB (2011) a loss of off-site electrical power and “reduction of the ability to remove heat to the atmosphere” are expected consequences of a design basis high wind. SÚJB (2011, p. 90-91) further describes the following possible consequences of high wind: contemporaneous loss of all the four cooling towers; possible failure of the 400kV and 110kV grids and transfer to the electrical emergency power systems; loss of the ultimate heat sink (cooling towers) leading to insufficient cooling of emergency diesel generators with risk of failure and gradual transfer to station black out conditions; adverse effects on the essential service water pumps due to possible damage of the central pump station roof. It is further stated that it has been shown that the resulting hazard cannot be handled by emergency procedures. It is concluded that the situation necessitates constructional modifications (SÚJB, 2011). Estimations of safety margins against ***snow load*** revealed that the resistance of the roof of the turbine hall corresponds to a load that is lower than the load computed for the 100-years maximum snow load. Discussion during the Stress Tests further addressed some effects of long-lasting ***extremely low temperatures.*** Such conditions may endanger the operation of water-management civil structures with free water level by the occurrence of ice, freezing of safety-related pipelines and the congelation of diesel fuel of the emergency diesel generators. It is noted that the NAcP (SÚJB, 2012) addresses several of these issues (action 1, structures reinforcement against extreme climatic phenomena; action 33, Implementation of ventilator towers; action 52, Procedure for coping with extreme weather conditions; etc.). At the Bilateral Meeting ČEZ (2013) provided first information on the implementation of two additional ESW fan cooling towers to increase robustness against high wind. References: ČEZ (2013). Nuclear Power Plants Status. Information provided during the discussions at the 22nd Czech-Austrian Bilateral Meeting, Langenlois, October 21/22 ENSREG (2012). Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/393 SÚJB (2011). National Report on “Stress Tests” NPP Dukovany and NPP Temelin Czech Republic. Evaluation of Safety and Safety Margins in the Light of the Accident of the NPP Fukushima. http://www.ensreg.eu/node/369 SÚJB (2012). Post Fukushima National Action Plan (NAcP)on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic. http://www.ensreg.eu/node/695

<table>
<tr><td>To be discussed</td><td>The requested workshop should address the following topics:
The derivation of the design bases for heavy weather conditions is not very clear. ENSREG (2012) concluded that it appears that many expert judgments are applied instead of data-based hazard assessments. The workshop should therefore be used to explain the database and methods of meteorological hazard assessments and discuss the uncertainties of the resulting design basis values.
ENSREG (2012) suggests to use a hazard return frequency of 10^{-4} per annum for plant reviews/back-fitting with respect to external hazards safety cases. Do the actions listed in the NAcP address back-fitting of all safety classified SSCs to that value (i.e., the “extreme design basis loads”)?
SÚJB (2011) mentions hazard assessments for extreme wind and an assessment of safety margins, which were performed in 2008 and 2009 - 2010, respectively. A more detailed explanation of the results of these studies would be highly appreciated.
Data published in the Stress Tests documents show that several civil structures currently do not meet the design basis requirements with respect to wind and snow loads. What kinds of measures are envisaged (e.g., in the NAcP) to retrofit these structures, and what is the time schedule for these measures?
ENSREG (2012) pointed out that some problems resulting from extremely low temperatures should be reconsidered (freezing of open water, pipelines, and congelation of diesel fuel). What are the results of the re-assessment of the possible impact of extremely low temperatures?
Further, comprehensive explanation of the following actions included in the NAcP (SÚJB, 2012) is requested:
The measures planned to resolve the inadequate resilience of the essential service water cooling function against extreme wind (SÚJB, 2012, Action 33) is addressed by the implementation of two new ESW fan cooling towers (ČEZ, 2013). The safety classification and design basis for these new installations should be clarified (in particular with respect to seismic and extreme weather).
The elaboration of procedures for handling extreme meteorological conditions is considered in the NAcP (SÚJB, 2012, Actions 7, 8, and 52). What is the current status of these activities?</td></tr>
<tr><td>Safety importance</td><td>High</td></tr>
<tr><td>Expected schedule</td><td>Medium term</td></tr>
<tr><td>Follow-up</td><td>Dedicated workshop</td></tr>
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Czech Republic	
Topic 1: Initiating events	
Issue No	**CZ 1.7**
Title	Seismic hazard assessment, NPP Temelín
Content	The issue of seismic hazard assessment for the Temelín site derived from the Melk Process, which led to the implementation of the two Interfacing Projects (Austrian- and Czech Interfacing Project) dealing with the assessment of potential active faults in the near-region of Temelín. Both projects finished their Final Reports in 2011. During the Stress Tests it was said that the results of both project have been integrated into an updated seismic hazard assessment (SHA), which is mentioned in the Stress Test documents. The results of the re-assessment have not been communicated during the Stress Tests as it was explained that the study still had to be reviewed at that time. The results of the SHA have not been presented so far.
Safety relevance	Reliable and realistic hazard assessments are of utmost importance for defining the seismic design base. As an outcome of the Stress Tests ENSREG suggests strengthening Periodic Safety Reviews by regular reviews of the design and beyond design hazards, including seismic.
Background	In the past years Czech and Austrian geoscientists made substantial efforts to update the database of seismic hazard assessment for Temelín NPP by novel geological, geophysical and paleoseismological investigations. The results of this joint efforts have been published (AIP, 2011; CIP 2011) and discussed in the framework of a Czech-Austrian Bilateral Meeting at Hrotovice/Dukovany between 26.-27.11.2012. It was said at that workshop that the novel data are accounted for in an updated seismic hazard assessment. The results of that study, however, were not presented as a review by independent experts from IAEA was still pending at that time. Parts of the new SHA are apparently included in the Initial Safety Analysis Report for the new nuclear installation of the units 3+4 at the Temelín site (ČEZ, 2012; page 303-458), which includes data on the geological, geotechnical and seismological situation at the site. The seismic hazard of SL-2 is given by a ground motion of PGA=47cm/s^2 (≈ 0.05g) for 84% non-exceedance probability in 10.000 years. The cited report suggests that the study is based on the data by CIP (2011) and paleoseismological data from the Vienna Basin obtained by AIP (2011). However, it appears that the results obtained from the Hluboká fault in the near-region of the site, which is a capable fault according to the data by AIP, are not considered. In April 2013 SÚJB initiated a review of the new SHA by an IAEA Expert Mission. This mission was open to an Austrian expert acting as an observer by courtesy of SÚJB. The evaluation of the SHA has apparently been completed shortly after the mission. The Project Team has no detailed information about the SHA study. A document on the environmental impact analysis of Temelín 3+4 issued by MPZ suggests that possible suggestions by IAEA to supplement or modify the new SHA needs to be considered by ČEZ (MPZ, 2013; Point 3). Point 5 of the cited document could further be interpreted in a way that ČEZ is obliged to

	publish the recommendations by IAEA. References: AIP (Decker, K., Homolová, D. & Porpaczy, C.) (2011). Paleoseismology of Temelin’s Near-Regional Faults. Final Report to BMLFUW, http://www.dafne.at/dafne_plus_homepage/index.php?section=dafneplus&content=result&come_from=&project_id=2915&PHPSESSID=6f68ap71m21u84k7u808bovnp0&mode=textonly&mode=multimedia ČEZ (2012): Initial Safety Analysis Report for the New Nuclear Installation Units 3 and 4 at the Temelin Site, Prague, 2012, 905 pp. CIP (Špaček, P., Prachař I., Valenta, J., Štěpančiková, P., Švancara, J., Piscač, J., Pazdírková, J., Hanžlová, R., Havíř, J. & Málek, J.) (2011). Qua-ternary activiry of the Hluboká Fault. Abridged translation of updated final report for project „Paleoseismology of the fault structures near NPP Temelin“, http://www.ipe.muni.cz/newweb/english/temelin_en/hluboka_fault.php MZP (2013): Abschließender Standpunkt des MZP (MZP 2013): Stellungnahme zur Prüfung der Auswirkungen der Realisierung des Vorhabens auf die Umwelt gemäß § 10 des Gesetzes Nr. 100/201 Slg; Umweltministerium MZP, Prag, 18. Jan 2013 (translation in German language)
To be discussed	A detailed presentation and discussion of the contents, database, basic assumptions, and results of the SHA as well as for information about the recommendations by IAEA is requested. The workshop format is proposed to for this issue to allow for the continued exchange of data between the Czech and Austrian expert groups. Information and requested discussion should address the following topics: ➢ The seismotectonic model on which the SHA is based. ➢ The seismological and geological database. ➢ The assumptions that have been made with respect to source zone selection, ground motion prediction equations, site effects etc. ➢ The methodology used for SHA. The Project Team asks for information about the results of the IAEA Mission 2013. In the case that the mission suggested modifications or supplements to the SHA, information is requested on the schedule to implement theses suggestion. As the SHA under discussion apparently also covers the area around Dukovany NPP it is proposed to combine the discussion on both sites into one workshop (Issue CZ 1.8).
Safety importance	High
Expected schedule	Short term
Follow-up	Dedicated workshop (together with CZ 1.8)

Czech Republic	
Topic 1: Initiating events	
Issue No	**CZ 1.8**
Title	Seismic hazard assessment, NPP Dukovany
Content	Czech geoscientists have prepared a new seismic hazard assessment for the Bohemian Massif, which is based on an updated geological and seismological database. The latter include recent paleoseismological data obtained from the Bohemian Massif and the Vienna Basin, which show that the magnitude of the strongest earthquakes that may occur in some regions around the site is significantly higher than previously assumed. Novel data further suggest that the Diendorf-Boskovice Fault at a distance of only 10km from the Dukovany site should be considered in seismic hazard assessment. The Project team asks for information on the results of that updated hazard assessment for the Dukovany site.
Safety relevance	The NPP Dukovany is currently being upgraded to f 0.1g, which is the minimum design value suggested by IAEA. Seismic margins are expected to remain small even after the upgrade is completed. Reliable seismic hazard assessment therefore is of high safety relevance. (See also CZ 1.2 and 1.3) As an outcome of the Stress Tests ENSREG (2012) suggests strengthening Periodic Safety Reviews by regular reviews of the design and beyond design hazards, including seismic.
Background	In the past years ČEZ took a major effort to update the seismic hazard assessment (SHA) for the Temelín site. The Project Team has no access to this study (see CZ 1.7 for background information). This study collected novel geological, seismological and paleoseismological data from a region that extends several hundred kilometers from Temelín. It is therefore expected that the study also provided an opportunity to re-assess the seismic hazard of the Dukovany site, although such an assessment may have been beyond the original scope of the analysis. The report by ČEZ (2012) apparently contains parts of the seismic hazard study mentioned above. The document suggests that the new SHA considers recent paleoseismological results from the Vienna Basin and the Czech Republic. The paleoseismological data include the finding that the seismic source zone encompassing the Vienna Basin Fault System is characterized by a maximum magnitude of M=7, which is significantly higher than previously assumed. The importance of that finding for the hazard at the Dukovany site, which is located at a distance of 90-100km from the Vienna Basin Fault System, is unclear. The Dukovany site is located about 10km NW of the Diendorf-Boskovice Fault (also referred to as Diendorf–Čebín Structure) that extends from Austria throughout the Czech Republic. Novel geological data from that fault recently led to its classification as a "seismogenic fault", which is included in the European Database of Seismogenic Faults (SHARE, 2012). The novel assessment of the Diendorf-Boskovice Fault relies on independently derived geological data (Decker et al., 1999; Leichmann & Hejl, 1996), geomorphological evidence (Roštínský et al., 2013), geophysical data (Rötzl et al., 2002) and geodetic measurements (Pospíšil et al., 2009: 2012; 2013) that all indicate that the fault has been active throughout its youngest geological

	history. The seismological assessment of the fault so far is exclusively based on historical earthquake data, which essentially only cover the time period after 1900. These data are not adequate to draw safe conclusions on the fault's contribution to seismic hazard. The last periodic nuclear safety review (PSR) of Dukovany NPP was carried out in 2006 and 2007, after 20 years of operation (SÚJB, 2011). The acquisition of geological data for the re-assessment of seismic hazard in the next PSR should be initiated timely. References: ČEZ (2012): Initial Safety Analysis Report for the New Nuclear Installation Units 3 and 4 at the Temelín Site, Prague, 2012, 905 pp. Decker, K., 1999. Tektonische Auswertung integrierter geologischer, geophysikalischer, morphologischer und strukturgeologischer Daten. In: Heinrich, et al., Geogenes Naturraumpotential Horn-Hollabrunn etc., Projektbericht Bund-Bundesländerkooperation, 250 pp., Wien (Geol. B.-A.). ENSREG (2012). Compilation of recommendations and suggestions. Peer review of stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/512 Leichmann & Hejl, 1996. Quaternary tectonics at the eastern border of the Bohemian massif: new outcrop evidence. Geological Magazine 133: 103-105. Pospíšil, L., Švábenský, O., Weigel, J., Witiska, M., 2009. Geodetic and geophysical analyses of Diendorf–Čebín Tectonic Zone. Acta Geodynamica et Geomaterialia 6: 309–321. Pospíšil, L., Švábenský, O., Weigel, J., Witiska, M., 2010. Geological constraints on the GPS and precise leveling measurements along the Diendorf–Čebín Tectonic Zone. Acta Geodynamica et Geomaterialia 7: 317–333. Pospíšil, L., Roštínský, P., Švábenský, O., Weigel, J., Witiska, M., 2012. Active tectonics in the eastern margin of the Bohemian Massif — based on the geophysical, geomorphological and GPS data. Acta Geodynamica et Geomaterialia 9: 315–329. Rötzl, R., Decker, K., Hübl, G., Römer, A. & Supper, R., 2002. Synoptische und integrative Auswertung geologischer, geophysikalischer, morphologischer und strukturgeologischer Daten am Diendorfer Störungssystem. Abstr. Pangeo Austria I: 148-149 (Univ. Salzburg). Roštínský, P., Pospíšil, L. & Švábenský, O. (2013). Recent geodynamic and geomorphological analyses of the Diendorf–Čebín Tectonic Zone, Czech Republic. Tectonophysics, 599: 45-66. SHARE (2012). European Database of Seismogenic Faults. Source ATCS014 Diendorf-Boskovice. http://diss.rm.ingv.it/share-edsf/

To be discussed	The Project Team asks for information about the novel seismic hazard study and its implications for the Dukovany site. Requested information includes: ➢ The seismotectonic model on which the SHA is based. ➢ The seismological and geological database. ➢ The assumptions that have been made with respect to source zone selection, ground motion prediction equations, site effects etc. ➢ The methodology used for SHA. ➢ The hazard level of the Dukovany site. Due to the overlap with the contents of Issue CZ 1.8 a combined workshop addressing both issues is suggested. The Project Team further offers to provide Czech Experts with a summary of the evidence that led to include the Diendorf-Boskovice Fault in the European Database of Seismogenic Faults (SHARE, 2012).
Safety importance	High
Expected schedule	Short term
Follow-up	Dedicated workshop (together with CZ 1.7)

3.2 Topic 2: Loss of Safety Systems

Czech Republic	
Topic 2: Loss of safety systems	
Issue No	**CZ 2.1**
Title	Enhancement of heat removal from the RCS and SFP, NPPs Dukovany and Temelín
Content	Implementation of diversified means for the heat removal from RCS and SFP, including pre-prepared connection to the existing systems. For Dukovany NPP the alternate means include the filling of SGs by firefighting system(s) and filling the open RCS and SFP using gravity feed from the trays (Bubble condenser system). For Temelín NPP there is intention to use mobile firefighting pumps as an alternative source.
Safety relevance	In the case of a loss of ES, the heat removal from the RCS and the SFP cannot be warranted. The consequences of such event would be the inability to remove the heat and: • Damage to the fuel in the RCS and SFP. • Release of radioactivity into the environment as a consequence of boiling in the open reactor or in the SFP. To prevent such a sequence of events, modifications are planned that primarily aim at installing the necessary connection to enable cooling with mobile equipment (like fire trucks, taking suction from any available source on or off site), but also alternate equipment that might be operational. It is expected that appropriate procedures will be modified/improved to take credit for the remedial actions envisaged.
Background	As an alternative heat sink for **Dukovany NPP**, it is proposed to pump water from fire trucks into SG through the so-called super emergency feedwater system (SÚJB, 2011). This water will evaporate in the secondary side of the steam generator and the steam will be released into the atmosphere (secondary feed&bleed). In addition, it is stated that this approach is not appropriate as an alternative method of heat removal from the Essential Service Water (TVD) consumers. The connections to inject water from the fire brigade equipment are already available at Dukovany, and are planned to be installed in Temelín. In Dukovany NPP, 3 fire trucks were available at the time of the Stress test, which can be used to feed the steam generators. Purchase of one more fire truck was initiated to have at least one fire truck available for each unit. In **Temelín NPP** enough fire trucks are present. However, no water connection points are available on relevant systems. Safety improvement measure was decided by the licensee to resolve this issue. The first phase of system modification will be realized in 2012, and the full implementation is planned in 2013. The following individual modifications are planned: • Provision of back-up water supply into SG from external mobile equipment using external connection points (SÚJB, 2012; EDU Action 13, ETE Action 14). • Provision of back-up coolant supply into depressurised reactor and storage pools with additional and sufficient sources of coolant (SÚJB, 2012; EDU Action 15, ETE Action 16).

	• Emergency cooling method – implementation of another ultimate emergency feedwater pump to SG (SÚJB, 2012; EDU Action 17). • Provision of heat removal from the key safety components during SBO (SÚJB, 2012; EDU Action 29, ETE Action 30). • Analysis for the SG gravity feeding use in EOPs is to be finished and subsequently EOPs are to be updated (SÚJB, 2012; ETE Action 73). References: SÚJB (2011). National Report on "Stress Tests" NPP Dukovany and NPP Temelin Czech Republic. Evaluation of Safety and Safety Margins in the Light of the Accident of the NPP Fukushima. http://www.ensreg.eu/node/369 SÚJB (2012). Post Fukushima National Action Plan (NAcP)on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic. http://www.ensreg.eu/node/695
To be discussed	The information of interest include ➢ Details on the installation of the connection points for the water injection from fire trucks for Temelín NPP. ➢ Concept for the cooling of the SFP on both plants. ➢ Design solution for the heat removal form safety components, in a case of unavailability of TVD. ➢ The assumptions relevant for the gravity feed into the RCS.
Safety importance	High
Expected schedule	Short term
Follow-up	Check list

Czech Republic	
Topic 2: Loss of safety systems	
Issue No	**CZ 2.2**
Title	Backup power supply for operation of communication equipment on site, NPPs Dukovany
Content	Backup power supply will be made available for operation of communication equipment on site (e.g. ECC, shelters, SÚJB, IZS MCR personnel, etc.)
Safety relevance	At present, most of the communication equipment including the emergency notification like sirens and the site communication system does not have a proper back up power supply. In a case of large-scale damage the communication between the control centers, and to external bodies (SUJB crisis management teams, regional entities, etc.) may become unavailable. This might lead to a loss of operability of the control centers/personnel implementing actions, which would make emergency mitigation actions even more complicated.
Background	In case of severe accidents, the decision making process is supported by technical support centre personnel and plant control is initially carried out by control room personnel. Upon activation (when the severity of the accident requires the use of emergency procedures/SAMGs) the TSC provides information for plant status evaluation and decision making to support the staff in the control room by additional information to be used to control the plant. The TSC is located in the emergency control centre (ECC). In accidents when the offsite or emergency power supply is available, the operability of the ECC is ensured for at least 72 hours without external support. It has filtered ventilation system and a possibility to be isolated from the external environment. The ECC does not have a dedicated power supply that would ensure its continuous operation under SBO conditions. This has been identified as a weak point during Stress Tests. As a consequence, a decision was taken to assure the power supply for the ECC from an external DG. The backup supply for operation of the communication system (HŘS, shelters, HZSp, SUJB, IZS, MCR staff) and for the warning system on-site is ensured in the case of the loss of supply or damage to the infrastructure, but only within several hours. Sirens in the buildings of EDU and the intra-company broadcasting do not have a backup power supply. The fixed telephone network, mobile telephone network, transmitters, warning means, etc., are not secured against major damage to the infrastructure. Communication might available through HZSp transmitters to the other part of IZS (fire brigade in Třebíč). A long SBO could result in the loss of the power supply to telephone exchange at EDU as well as at other locations that need to operate in emergencies. The only exceptions are the ČEPS in Prague and Ostrava, which have their own DGs. This might limit the possibilities to restore the power supply from external resources outside (e.g. EDA, or VE Vranov), due to a difficulty in establishing communication. Active elements of the Duknet network are mostly supplied from switchboards (including user PC) and supported by UPS. The central node in administrative building is supported for a maximum period of 2 hours. The MPLS WAN ČEZ network, which ensures the connection between data centres and individual localities of ČEZ, is supported for 1 hour in the case of the loss of power supply. Safety improvement measures are planned to resolve these issues:

	• Provision of the back-up power supply for the site security systems, shelters and of the telephone exchanges, communications, lighting, etc. (SÚJB, 2012,EDU Action 34) • Provision of the back-up power supply of telephone exchanges, communications and radio network (SÚJB , 2012,ETE Action 35) References: ENSREG (2012). Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/393 SÚJB (2012). Post Fukushima National Action Plan (NAcP)on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic. http://www.ensreg.eu/node/695
To be discussed	The information of interest include ➢ Details on the design of the backup power supply system with emphasis on the duration of available supply for different scenarios ➢ Schedule of the installation, in particular for the main communication channels
Safety importance	Medium
Expected schedule	Short term
Follow-up	Check list

Czech Republic	
Topic 2: Loss of safety systems	
Issue No	**CZ 2.3**
Title	Alternative means for cooling of I&C equipment, NPPs Dukovany and Temelín
Content	Alternative means will be implemented for securing the cooling of I&C necessary for monitoring and controlling selected safety relevant SSCs. Mobile firefighting pumps might be used for this purpose.
Safety relevance	In case of SBO, the loss of ESW will limit the ability to cool specific rooms, which in turn might results in the increase of room temperature and loss of vital I&C components. This would limit the ability of operators to monitor the technological parameters but also the ability to control certain safety and non safety equipment.
Background	At **Temelín NPP**, if a unit needs to be cooled to a cold shutdown state, the following steps are necessary: • Within about 48 hours after the SBO event, activate the emergency supply systems to increase the concentration of boric acid and transfer heat. • Before launching the process of cooling the unit to a cold shutdown state, the containment must be isolated, as during the pressure reduction in the RCS, and in particular when initiating the primary “feed & bleed”, the coolant might/would be released into the containment. To initiate the cooling, safety relief valves on the pressuriser and the isolation valves on the hydro accumulators need to operate. The sprinkler system for the containment pressure reduction needs to be activated. These measures require maintaining the functionality of all necessary I&C and ensuring the functionality of the corresponding auxiliary systems. The ventilation system that provides cooling of the rooms containing equipment for the emergency water supply for the SG and the RCS, electrical rooms and I&C. According to analyses, failed ventilation would lead to a critical temperature increase in some of the I&C rooms within 60 minutes after an SBO event. Loss of the ESW in case of a SBO would lead to a loss of the ventilation system. Although the I&C would remain operable (as it is battery powered) it will ultimately lose the functionality due to the increase of the temperature in the I&C rooms. This would lead to a loss of indications/parameters providing the status of the units, and loss of ability to control (some of the) safety equipment. While similar analysis could not be found in SÚJB (2011) for **Dukovany NPP**, improvements seem to be planned for both Dukovany and Temelín NPPs (SÚJB, 2012). Safety improvement measures are planned to resolve this issue: • Provision of heat removal from the I&C systems/rooms to enable long-term monitoring of key parameters during SBO (SÚJB, 2012, EDU Action 25, ETE Action 26). • Provision of heat removal from the key safety components during the SBO (SÚJB, 2012, EDU Action 29, ETE Action 30)

<table>
<tr><td></td><td>References:
SÚJB (2011). National Report on “Stress Tests” NPP Dukovany and NPP Temelin Czech Republic. Evaluation of Safety and Safety Margins in the Light of the Accident of the NPP Fukushima. http://www.ensreg.eu/node/369
SÚJB (2012). Post Fukushima National Action Plan (NAcP) on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic. http://www.ensreg.eu/node/695</td></tr>
<tr><td>To be discussed</td><td>The information of interest includes:
➢ The design concept for the alternate cooling of the I&C equipment.
➢ Major activities, additional equipment and procedures to achieve necessary cooling of I&C equipment.
➢ Schedule of the implementation at the NPPs Dukovany and Temelín.</td></tr>
<tr><td>Safety importance</td><td>Medium</td></tr>
<tr><td>Expected schedule</td><td>Medium term</td></tr>
<tr><td>Follow-up</td><td>Check list</td></tr>
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<table>
<tr><td colspan="2">Czech Republic</td></tr>
<tr><td colspan="2">Topic 2: Loss of safety systems</td></tr>
<tr><td>Issue No</td><td>CZ 2.4</td></tr>
<tr><td>Title</td><td>Alternative AC power supply, NPPs Dukovany and Temelín</td></tr>
<tr><td>Content</td><td>Provision of alternative AC supply for safety equipment to ensure cooling and heat removal from RCS and SFP, including the option for the connections. This alternative power supply is to be assured by means of mobile sources as well as dedicated connection to additional on site and off site sources.</td></tr>
<tr><td>Safety relevance</td><td>In the case of long-lasting SBO there is a threat to the integrity of fuel in the RCS and SFP. Without available alternate AC power, the heat removal from RCS or SFP cannot be ensured. The availability of alternate power supply would assure the operability of dedicated equipment, and thus prevent damage of the fuel.</td></tr>
<tr><td>Background</td><td>In case of loss of off-site power and loss of the ordinary back-up AC power source, the main strategy at Dukovany plant is to recover AC power via separate lines (alternate grid) from two hydroelectric power plants, which have black-start capability. This requires the operability of the external grid 400 kV and 110 kV sections. However, the electrical connection lines between Dukovany NPP and the hydroelectric power plants are not seismically qualified (SÚJB, 2011).

The current plant design does not include other dedicated provisions against simultaneous loss of off-site power and loss of the ordinary back-up AC power source (e.g. diverse or mobile generators). It is proposed to increase the plant robustness by implementation of alternative means for AC power supply for core cooling and heat removal, these being listed in the National Report and Action Plan:
• Implementation of additional stationary source of power supply (SBO-DG) for subsequent increasing of resistance against „station blackout“ scenario (SÚJB, 2012, EDU Action 18, ETE Action 19).
• Provision of alternative fuel filling for long-term operation of DG including providing of fuel sources (SÚJB, 2012, EDU/ETE Action 22).
• Provision of alternative mobile devices for alternative fluids pump and provision of power supply (SÚJB, 2012, EDU Action 38, ETE Action 39).
• Analyzing of off-site power connections reinforcement. Subsequent reinforcements, if necessary (SÚJB, 2012, EDU/ETE Action 74).

References:
ENSREG (2012). Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/393

SÚJB (2011). National Report on “Stress Tests” NPP Dukovany and NPP Temelin Czech Republic. Evaluation of Safety and Safety Margins in the Light of the Accident of the NPP Fukushima. http://www.ensreg.eu/node/369

SÚJB (2012). Post Fukushima National Action Plan (NAcP) on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic. http://www.ensreg.eu/node/695</td></tr>
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To be discussed	The thematic workshop is expected to provide a comprehensive presentation on the design basis and the design solutions for ensuring alternative AC power supply. The following issues are of interest: ➢ The design basis for the SBO DGs (seismic resistance, resistance against other external hazards, spectrum of sequences to be protected against). ➢ The safety effect (i.e. in a SBO sequence) of adding SBO-DGs, planned consumers, sizing, autonomy (e.g. fuel availability, requirements for cooling and lubrication). ➢ How are the connections to the existing distribution system/loads for those SBO DGs to be implemented? ➢ Have the procedures for starting and connecting the SBO DGs to each safety bus been developed, verified, and tested? How long would it take to connect those SBO DGs to the essential loads? ➢ How is the load shedding to protect the SBO DGs from overload being organised, and which loads are selected as essential ones? Have procedures for this operation been developed, tested and verified? ➢ What is the schedule for licensing and implementation? ➢ What is the basis for choice of alternate sources, planned consumers, sizing, autonomy, etc.? ➢ Results of analysis of off-site power connections reinforcement, proposed solutions and schedule for design, licensing and implementation.
Safety importance	High
Expected schedule	Medium term
Follow-up	Dedicated workshop (together with CZ 2.6)

Czech Republic	
Topic 2: Loss of safety systems	
Issue No	**CZ 2.5**
Title	Reliability of the containment isolation (valves), NPP Temelín
Content	The reliability of the containment isolation will be increased by assuring that the isolation valves of the containment ventilation system are powered from the battery backed supplies.
Safety relevance	The containment isolation system is the most important element of assuring the integrity and preventing the release of radioactivity into the environment. Some of the valves on the containment isolation are air powered. Others including the ventilation system are motor operated requiring electricity for their operation. In a case of loss of electric supply, those valves might be left in open position, thus resulting in a non-isolated containment. Powering these valves from battery powered supplies will assure that in a case of a SBO, the containment isolation function is successful.
Background	The integrity of the containments within the Temelín NPP is ensured, among other systems, by the containment isolation system – separating valves automatically closed when the pressure in the containment increases. Its operability depends on power supply. The limited capacity of the accumulator batteries of the Category I SPSS could complicate certain essential safety activities such as containment isolation, the discharge of the batteries leading to the loss of power of the separating valves. In case of disrupted isolation of the containment radioactive substances may leak into the surrounding environment. Safety improvement measures are planned to resolve this issue: • Implementation of measures for maintaining long-term containment integrity according to selected severe accident management strategies (SÚJB, 2012, ETE Action 50). References: SÚJB (2012). Post Fukushima National Action Plan (NAcP) on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic. http://www.ensreg.eu/node/695
To be discussed	The information of interest includes: ➢ Details on the concept of assuring the containment isolation (operability of the valves) in a case of loss of power. ➢ Procedures that are in place or planned to control/assure the isolation of the containment during the SBO.
Safety importance	Medium
Schedule	Short term
Follow-up	Check list

Czech Republic	
Topic 2: Loss of safety systems	
Issue No	**CZ 2.6**
Title	Enhance the availability of the accumulator batteries, NPPs Dukovany and Temelín
Content	Increased availability of accumulator batteries to supply electricity to important users could be achieved by both optimised discharge (shedding of unnecessary load), installing batteries of higher capacity, or assuring additional/alternate means of charging. All these approaches are planned at Temelín and Dukovany. The implementation will result in a significant increase of the discharge time, thus assuring (longer) availability of the battery backed consumers.
Safety relevance	In a case of a SBO, the last line of defence is the battery backed systems. This will typically include I&C allowing monitoring of relevant parameters but also control of selected equipment, allowing for e.g. heat removal via SGs. Because of that the discharge of batteries is one of the cliff edges for the SBO sequences. An extended battery discharge time would allow for a longer time for recovery and/or alternative remedial actions. Battery availability is a limiting factor for safety of the unit in a SBO sequence. Until the batteries are discharged, the power supply for key valves, I&C for key parameters, control circuits, emergency lighting etc. is preserved. In case of a full loss of the AC power supply (SBO) and if all the following levels of defence in-depth fail at the same time, the only sources supplying safety systems and safety related systems are emergency sources of uninterrupted DC power supply (accumulator batteries). If the corresponding DG does not run, the accumulator batteries are not being recharged and their discharge period takes limited hours, depending on the load.
Background	In case all AC power sources are lost, the accumulator battery can supply DC/AC power to the consumers that are connected to the uninterruptible power supply. All the units of both plants are equipped with 3 accumulator battery sets, each of them being capable to implement the designated monitoring and control functions (redundancy 3x100%). For example, the capacity of the accumulator battery sets of Dukovany uninterruptable power supply SZN1, 2 and 3 is 1500 Ah. According to the design, the discharge time of accumulator batteries with the maximum load is at least 2 hours. Procedures have been developed to disconnect loads with less important safety functions and conserve the DC capacity. Consequently, the actual battery depletion time may be much longer than two hours. Based on the fact that battery depletion leads to an important cliff edge effect, further improvements are listed in the National Report (SÚJB, 2011) and NAcP (SÚJB, 2012): • Implementation of alternative measures to ensure recharging batteries in case of SBO and implementation of measures to extend batteries discharging time (SÚJB, 2012, EDU Action 20, ETE Action 21). • Performing battery capacity real load tests (SÚJB, 2012, EDU/ETE Action 75). References: ENSREG (2012). Peer review country report. Stress tests performed on

	European nuclear power plants. http://www.ensreg.eu/node/393 SÚJB (2011). National Report on "Stress Tests" NPP Dukovany and NPP Temelin Czech Republic. Evaluation of Safety and Safety Margins in the Light of the Accident of the NPP Fukushima. http://www.ensreg.eu/node/369 SÚJB (2012). Post Fukushima National Action Plan (NAcP) on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic. http://www.ensreg.eu/node/695
To be discussed	The thematic workshop is expected to provide a comprehensive presentation on the design basis and the design solutions for increasing the availability of accumulator batteries. The following issues are of interest: ➢ Technical solutions chosen and basis for the choices. ➢ Planned consumers, sizing, autonomy. ➢ How is the connection being implemented. ➢ Schedule for licensing and implementation.
Safety importance	High
Expected schedule	Medium term
Follow-up	Dedicated workshop (together with CZ 2.4)

Czech Republic	
Topic 2: Loss of safety systems	
Issue No	**CZ 2.7**
Title	Extension of alternate cooling through the SG, NPP Dukovany (Action 17)
Content	An additional emergency feedwater pump (approx. 160 kW) will be provided to feed the SGs taking suction from the tanks of demineralized water or from the other off-site sources.
Safety relevance	Extension of options for heat removal from the core increases the ability of the plant to withstand the fuel damage.
Background	In addition to normal and emergency water supply to the SG, one of the post Fukushima improvements is the arrangement for a mobile fire water pumps to supply the SGs. Using prepared connection points, demineralised water can be added directly into the SGs using mobile fire water pumps (pressure on delivery of the pump 0.8-1.2 MPa, flow 120-150 t/h). The alternative manner of cooling of SG as described in EOPs was tested. The capacity for the supply has been verified and it is sufficient for fulfilling the safety functions. Nevertheless, it seems that another ultimate emergency feed water pump is planned, also to take the suction from the demineralised water tank. This pump appears to be a part of the bunker/hardened system concept. ➢ Emergency cooling method – implementation of an additional ultimate emergency feedwater pump to SG (SÚJB, 2012, EDE Action 17). References: SÚJB (2012). Post Fukushima National Action Plan (NAcP) on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic. http://www.ensreg.eu/node/695
To be discussed	The information of interest includes: ➢ The details on the design of the alternate actions to increase the availability of water supply to the SGs. ➢ Accident sequences considered where the alternate cooling will be used. ➢ Equipment and procedures to be installed/developed to assure the alternate cooling though the SGs. ➢ Schedule for the completion of the installation.
Safety importance	High
Expected schedule	Long term
Follow-up	Dedicated presentation

<table>
<tr><td colspan="2">Czech Republic</td></tr>
<tr><td colspan="2">Topic 2: Loss of safety systems topic 3/Severe accidents</td></tr>
<tr><td>Issue No</td><td>CZ 2.8</td></tr>
<tr><td>Title</td><td>Increase of ability to control the key parameters at the post-accident phase, NPP Dukovany (NAcP Action 27)</td></tr>
<tr><td>Content</td><td>Addition of important measurements into post-accident monitoring system – the addition of radiation situation measurement and SFP condition into PAMS.</td></tr>
<tr><td>Safety relevance</td><td>Effectiveness of the accident management measures depend on the available information on the status of the facility. Currently, the measurements of the conditions of the spent fuel storage pool during accidents are only displayed in the MCR. They are neither available in the ECR, nor in the post-accident monitoring system (PAMS).</td></tr>
<tr><td>Background</td><td>All required information about the state of the components and values of the parameters essential for coping with severe accidents are available in the PAMS and they are either processed directly in the PAMS or sent to other I&C of safety systems.

The radiation levels inside and outside the site are monitored through the system of radiation inspection (CISRK). In the current design, this system is not seismically qualified for the design basis earthquake. The system is located in premises that do not have seismic resistance to earthquakes with the intensity > 6° MSK-64 (horizontal PGA > 0.05g). The system does not have the power supply from a 1st category secured supply. Alternative measurements of radioactivity would only be possible by using portable measuring devices.

The measurements regarding the status of spent fuel storage pool (SFSP temperature, level, cooling system flow) are available only on the BD panels. The measurement of parameters related to the cooling of BSVP is not provided to the ND nor is it available in the PAMS. Similarly, there is no measurement of the radioactivity in the hall near SFSP that would be available in the PAMS.

Safety improvement measures are planned to resolve this issue (SÚJB, 2012):

Implementation of important measurements into post-accident monitoring system – the addition of RA situation measurement and SFP condition into PAMS (SÚJB, 2012, EDU Action 27)

References:
SÚJB (2012). Post Fukushima National Action Plan (NAcP) on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic. http://www.ensreg.eu/node/695</td></tr>
<tr><td>To be discussed</td><td>The presentation should describe in more detail the safety concept and design of the planned measure. The following information should be provided:
➢ Design basis (seismic qualification, harsh environment qualification) for the post-accident monitoring systems for SFSP parameters and the radiations situation in the vicinity.
➢ Radiation measurements of the SFSP and surrounding areas, and limitations of access that could challenge remedial actions in the area.
➢ Power supply for monitoring systems and for the PAMS.
➢ Planned availability of indications: MCR, ECR.</td></tr>
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Safety importance	High
Expected schedule	Long term
Follow-up	Dedicated presentation

3.3 Topic 3: Severe Accident Management

Czech Republic / Hungary / Slovakia	
Topic 3: Severe Accident Management	
Issue No	**CZ/HU/SK 3.1**
Title	Stabilization of molten core for reactors of the type VVER-440/213 (Bohunice, Dukovany, Mochovce, Paks)
Content	Implementation of this measure – stabilization of the molten core by cooling the reactor pressure vessel from outside – was already planned before the Fukushima accident, and indeed was already completed at some units at the time of the accident. The measure requires a number of technical modifications. Since the cooling of the RPV from the outside is a complex procedure, extensive analyses and experiments have been performed to demonstrate the feasibility. Of particular importance is the CERES test facility which permits to simulate the gap between RPV and biological shield 1:1 regarding elevation, with a 1:40 slide of the cylindrical structure. Furthermore, considerations for the case of failure of this measure have been performed in the three countries concerned. The assessment of and the approach to this problem appears to differ between the countries.
Safety relevance	There are two options to attempt to stabilize a molten core: Inside the reactor pressure vessel, by external vessel cooling; or, after melt-through of the RPV, by cooling in the reactor cavity. For smaller reactors, in particular VVER-440s, the former option (in-vessel retention) could, in principle, be practicable. (For larger reactors – roughly above 1.000 MWe – in-vessel retention does not appear feasible due to a less favourable ratio between decay heat and RPV surface.) Successful in-vessel retention leads to rather limited pressure increase in the containment (for VVER-440s, this is supported by the relatively large volume of the containment), and to limited release of radionuclides into the containment atmosphere. Comparatively low releases into the environment are the result. Insofar, the implementation of filtered venting can be seen with less urgency for VVER-440/213 than for VVER-1000. Without cooling and stabilization of the molten core inside the reactor vessel, containment failure appears likely. There appear to be differences in the assessments regarding the possible accident sequences in this case, and the severity of resulting releases, in the countries discussed here; the basis for these differences is not clear, and this point should be pursued further.
Background	<u>Implementation of external reactor pressure vessel (RPV) cooling</u> A number of technical modifications have to be performed to implement external cooling of the RPV: Modification of the drainage system of the bubble condenser, modifications in the reactor shaft to permit coolant flow along the RPV, modification of the ventilation piping to avoid losses of cooling water, strengthening of the hermetic door of the reactor cavity and others. According to the **Peer Review Country Reports** (ENSREG 2012a, 2012b, 2012c) and other sources, the schedule for implementation is as follows: EDU – until 2015

	Paks – between 2011 (unit 1) and 2014 (unit 4) EBO – 2010 EMO 1+2 – 2011/12 (EMO 3+4 – part of the original design) Thus, the implementation is already quite far advanced and it can be expected to continue according to the planned schedule. Demonstration of feasibility of external RPV cooling It is generally assumed (by the licensees as well as, subject to further review, the regulatory authorities) that the risk of vessel failure can be significantly reduced by implementing the strategy of cooling the reactor pressure vessel from outside. Analyses have been performed to investigate whether stable cooling can be assured through natural circulation of the coolant, maintaining the intactness of the RPV. In support of the calculations, experiments have been performed in the CERES test facility in Hungary. Information on analyses and experiments have been provided by the Hungarian side at the regular bilateral meeting Hungary-Austria 2012: 1. Research Results in Support of In-vessel Corium Retention Program in the Paks Nuclear Power Plant (lecture at European Review Meeting on Severe Accident Research (ERMSAR) 2012) 2. CERES experiments calculation with the ASTEC code (lecture at ERMSAR 2012) 3. CERES test facility and test results (presentation at regular bilateral meeting Hungary-Austria 2012) The first paper describes the CERES test facility which simulates the gap between RPV and biological shield (1:1 regarding elevation, with a 1:40 slide of the cylindrical structure). Results of experiments for different gap configurations are presented, as well as results of calculations for one case. It is concluded that removal of the decay heat could be demonstrated in all cases. The second paper provides results of analyses for another gap configuration. It concluded that there is good agreement between experiment and calculations, and that the coolability of the RPV has been demonstrated. The third document mostly summarizes the other two. The CERES experiments were mostly completed in late 2012. There was one remaining issue at that time: A test with boric acid, which was planned for 2013. No information on other comparable investigations has come to the attention of the Austrian experts. It can be assumed that the CERES experiments and the calculations carried out in this context constitute the mainstay of the demonstration of feasibility of external RPV cooling. Considerations for the case of RPV failure Different considerations regarding RPV failure have been performed in the three countries concerned. In the **Czech Republic**, the emphasis lies on cooling the steel door of the reactor shaft by flooding the shaft. No analysis has been performed; but according to “professional estimate”, failure of the door can be prevented. This would be

	followed by melt-through of the wall of the shaft after about 4 days after failure of the RPV bottom. It is pointed out that this *represents high and late damage to the containment. The concentration of fission products in the atmosphere of the containment would be low at this time* (National Stresstest Report (SÙJB 2011) section II.6.2.3, repeated in the Czech Report to the 2nd CNS EOM (CR 2012)). No information is available whether further analyses and preparation of measures is planned in this respect. In **Hungary**, two cases are distinguished: RPV failure before flooding of the reactor cavity, and after it. In the first case, it has to be decided whether flooding of the cavity should be still be performed, taking into account the possibility of a steam explosion. In the second case, *a relatively small amount of molten fuel will escape and then the solidifying debris will block the route* (National Stresstest Report section (HAEA 2011) 6.2.3). This seems to imply that RPV failure does not lead to major problems as long as flooding occurs sufficiently early. The basis for this statement is not clear; no information is provided whether there are analyses supporting it, or whether further analyses are planned. In **Slovakia**, it is assumed that failure of the cavity door is unlikely to be prevented in case of RPV failure. The failed door is expected to lead to releases outside the containment and a serious worsening of the accident progression. *Stabilization of the melt composition, termination of concrete degradation and long-term preservation of the cavity integrity cannot be guaranteed* by coolant feeding into the reactor cavity. Therefore, RPV failure prevention is given high importance and *no special additional measures were assumed for hypothetical corium cooling on the cavity bottom* (National Stresstest Report (UJDSR 2011) 6.3.5.2). The Slovak Report to the 2nd CNS Extraordinary Meeting (SR 2012) contains similar statements. In the Slovak National Action Plan (NAcP) (UJDSR 2012), this point is again emphasized: *Implementation of reliable in-vessel molten corium retention prevents complicated ex-vessel phenomena associated with core-concrete interaction, direct containment heating, production of non-condensable gases leading to containment over pressurization, etc.; all these phenomena are associated with large uncertainties (part III, section 'severe accident management')*. It is noteworthy that in the Peer Review Country Report (ENSREG 2012b), it is stated that RPV failure is considered very unlikely after the modifications for in-vessel retention. *Nevertheless, investigation to limit the consequences in case of RPV failure could be considered in further steps* (section 4.3). References: CR (2012). Czech Republic – Extraordinary National Report under the Convention of Nuclear Safety, February 2012. http://www.sujb.cz/fileadmin/sujb/docs/zpravy/narodni_zpravy/CZ_NR_2012.pdf ENSREG (2012a). Peer review country report – Czech Republic. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/393 ENSREG (2012b). Peer review country report - Slovakia. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/404

	ENSREG (2012c). Peer review country report – Hungary. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/398 HAEA (Hungarian Atomic Energy Authority) (2011). National Report of Hungary on the Targeted Safety Re-assessment of Paks Nuclear Power Plant, December 29, 2011. http://www.ensreg.eu/node/362 SR (2012). Special National Report of the Slovak Republic, compiled under the Convention of Nuclear Safety, April 2012. http://www.ujd.gov.sk/files/SNR_NS_April2012.pdf SÚJB (2011). National Report on "Stress Tests" NPP Dukovany and NPP Temelin Czech Republic. Evaluation of Safety and Safety Margins in the Light of the Accident of the NPP Fukushima. http://www.ensreg.eu/node/369 UJDSR (Nuclear Regulatory Authority of the Slovak Republic) (2011). The Stress Tests for Nuclear Power Plants in Slovakia. 30. December 2011. http://www.ensreg.eu/node/366 UJDSR (2012). Post Fukushima National Action Plan (NAcP) of the Slovak Republic. http://www.ensreg.eu/node/692
To be discussed	This measure - stabilization of the molten core by cooling the reactor pressure vessel from outside - has already been decided, the corresponding modifications have been planned in detail, and the implementation is already far advanced (by the end of 2013, it will be completed in more than half of the units concerned), although it follows different schedules in the different countries. The discussion should therefore focus primarily on the demonstration of the feasibility, and also on the considerations for the case of failure of the measure. <u>Demonstration of feasibility</u> The information provided by the Hungarian side (see above) gives an overview of the programme performed in Hungary to demonstrate the feasibility of in-vessel retention. The CERES test facility follows the geometry at Paks NPP. There may be some small differences in geometry between the VVER-440/213s under consideration here, but it can be assumed that the CERES results are also important for the other plants. After evaluation of the information provided, a number of questions remain open: • Has the test with boric acid, planned for 2013, already been performed? If so, what are the results? • The experiments are modelling a part of the whole system only (the cooling of the external vessel wall). The overall concept (e.g. containment spray system, piping from sump to reactor cavity) should be described in more detail. • Two load cases have been calculated with ASTEC/ANSYS. It is not clear to which extent they are representative for the whole spectrum of accidents. • Different widths of the gap between RPV and cavity wall have been studied in experiments and calculations. However, the case of complete

local gap closure was not considered, as far as can be seen. Can this case be excluded? If not, what would be the effect of a local closure?

- In the tests, stepwise increase of the thermal power has been implemented. It is not clear that all relevant cases are covered.
- The experiments show, that boiling crisis, drying-out of the wall and local temperature increases to up to 200° above boiling temperature can occur for brief periods of time. Subsequently, the wall is cooled again to boiling point when water flows up again. Have structure-mechanical analyses been performed to study possible consequences of this heating-cooling cycle of the RPV wall?
- The codes used for calculations (RELAP5 and ASTEC) predict the mass flow well; however, both codes appear to have difficulties in correctly predicting the boiling crisis at the wall.
- How reliable is the transfer of the results from a 1:40 slide to the full RPV circumference? Reliable codes are needed for such a transfer. Are RELAP5 and ASTEC adequate for this task, considering their limitations in predicting experimental results?
- Are there differences in geometry and/or other differences regarding the whole concept of IVR, between Paks and the other VVER-440/213s considered here? If so, what are the differences and how can the results of CERES be transferred to other plants in spite of these differences?

<u>Considerations for the case of RPV failure</u>

Different considerations have been performed in different countries. All in all, there is a number of questions which appear relevant:

- When the cavity is flooded after RPV failure, there is the hazard of a steam explosion. Should flooding be avoided completely in this case, or could there be circumstances in which it might be advantageous nevertheless? Are further analyses and investigations planned in this respect?
- What is the basis for the assumption that only a relatively small amount of molten fuel will escape and then the route will be blocked by solidifying debris (as assumed in Hungary)? Are further analyses and investigations planned in this respect?
- What is the basis for assuming that the integrity of the cavity door can be preserved by flooding (Czech Republic)? Further analyses and investigations planned?
- What is the basis for assuming that melt-through of the shaft will occur after about 4 days (Czech Republic)? To which extent will releases from the containment be reduced in this case, compared to early containment failure through failure of the cavity door? Which further analyses and investigations are planned?

The CERES experiments were expected to be completed by the end of 2013, and it can be assumed that the considerations for the case of RPV failure are on-going. The appropriate time for a workshop could be early 2016.

Safety importance	High
Expected schedule	Medium term
Follow-up	Dedicated workshop

Czech Republic	
Topic 3: Severe Accident Management	
Issue No	**CZ 3.2**
Title	Filtered containment venting at NPP Temelín
Content	Venting is a measure to protect the containment from overpressure if the containment spray system fails. It is also a means to reduce the amount of hydrogen and other non-condensable gases in the containment. Filtered venting is not installed at Temelín NPP. As a last resort, systems not intended for this purpose can be used for unfiltered venting, which would lead to considerable releases. At present, filtered venting is being under investigation as one possible measure to preserve long-term containment integrity. A decision concerning the implementation of such measures will be taken by the end of 2014; the further schedule is not clear yet.
Safety relevance	Venting is a measure to protect the containment from overpressure if the containment spray system fails. Furthermore, it can reduce the pressure by reducing the amount of hydrogen and other non-condensable gases in the containment. In case of venting, radioactive releases are inevitable; however, venting through filters permits a considerable reduction of these releases (apart from noble gases). The lack of a venting option can lead to containment failure due to overpressure during a severe accident, and to significant releases of radioactive nuclides. Unfiltered venting, too, leads to significant radioactive releases (although they are likely to be less than in case of a containment failure) and therefore can only be regarded as the last option to avoid overpressure failure.
Background	<u>Present situation regarding filtered venting, and future plans:</u> Containment venting at Temelín NPP is addressed in the **Licensee's Stresstest Report** (CEZ 2011, sections 6.3.2 and 6.3.3). It is pointed out that there are no dedicated systems for venting. As a last resort, systems which are not primarily intended for venting can be used to avoid containment failure due to overpressure. It is also emphasized that containment venting is seen as one of the means for hydrogen management. The present capacity of PARs in the containment is only sufficient for design-basis accident. However, preparation is under way to install a hydrogen removal system with sufficient capacity for severe accidents (see Issue CZ 3.3). This is of high importance for ETE considering that the issue of molten core stabilization is still open but stabilization outside the RPV is a likely option (see Issue CZ 3.4). Without venting, containment failure due to overpressure is likely in this case. In the **National Stresstest Report** (SÙJB 2011), it is stated that the possibility of containment venting with systems not designed for this purpose (filtered or unfiltered) has not been analysed yet (section III.6.3.2). Furthermore, it is stated that the authority *is considering to suggest to Temelín NPP to analyse the possibility and various alternatives of modifications to complete the original containment design with the feasible venting option for the case of severe accidents. […] The procedure should be coordinated with*

	other WWER-1000 type NPP operators and regulators (section IV.3.5). This implies that the issue might be investigated but it is not clear whether any measures will actually be taken. According to the **Peer Review Country Report** (ENSREG 2012a), the use of ventilation pathways not originally intended for venting is not justified because of the releases occurring in this case (which are considerably higher than in case of filtered venting). The advantages of a filtered venting system are emphasized. It is pointed out that a request by SÚJB to perform a feasibility study for the implementation of a filtered venting system was still open (section 4.2.1.3). The absence of a filtered venting system is listed as a weak point (section 4.2.2.2). In the Czech **Report to the 2nd CNS Extraordinary Meeting** (CR 2012), the option of venting for ETE is mentioned – it is stated that it has not yet been analysed (section 2.2.3.3). During the **Follow-up Fact Finding Site Visit** at Temelín in September 2012 (ENSREG 2012d), filtered venting is mentioned among the measures already decided or considered, as one option to protect the containment against overpressure. *Analysis, strategies and implementation schedule are planned for 2014* (section 3.1). In the **National Action Plan (NAcP)** (SÙJB 2012), two actions refer to this issue (section 6): Action 49: *Implementation of analysis and propose a strategy and schedule for implementation of measures for preservation of long-term containment integrity (to stabilize melt and prevent overpressure).* Action 50*: Implementation of measures for maintaining long-term containment integrity according to selected severe accident management strategies.* Both activities are listed as “in progress”; deadline for action 49 is 2014, for action 50 “according to schedule”. The latter clearly refers to the schedule which will be prepared in the course of action no 49. Hence, the schedule for implementation of measures is not clear and will not become clear before the end of 2014. Treatment of this Issue in the ETE Road Map process: This Issue has already been discussed in the framework of the ETE Road Map according to Chapter IV and V of the “Conclusions of the Melk Process and Follow-Up”. In the Final Monitoring Report for Item 7b (UBA 2005, Severe Accident Related Issues), section IV.3, it is stated that the possibility of venting the containment through the containment pressure test depressurization line through filters to the plant stack to reduce pressure and release hydrogen from the containment was under development. Heating due to fissions product collection in filters was mentioned as a problem. It was emphasized that the method for venting had not been confirmed yet, and that this issue therefore should stay on the agenda of future bilateral exchanges. At the Workshop with Plant Walkdown in September 2006, the Czech side stated that the operation of the filtered venting system had been checked, and the resistance of filters to the heat produced by accumulation of fission products was confirmed (UBA 2006, section 4).

	This topic was pursued further in the follow-up discussions concerning ETE 1+2 which took place 2007 – 2009. The information provided at the Workshop and Walkdown 2006 appears to be in contradiction with the statement in the National Stresstest Report (2011) that the possibility of venting using systems not designed for this purpose has not been analysed yet. References: CEZ (2011). Evaluation of Nuclear Safety and Safety Margins of Temelín NPP. http://www.cez.cz/edee/content/file/pro-media-2012/02-unor/final-report-st-ete.pdf CR (2012). Czech Republic – Extraordinary National Report under the Convention of Nuclear Safety, February 2012. http://www.sujb.cz/fileadmin/sujb/docs/zpravy/narodni_zpravy/CZ_NR_2012.pdf ENSREG (2012a). Peer review country report – Czech Republic. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/393 ENSREG (2012d). Stress test peer review Follow-up fact finding site visit – Czech Republic. http://www.ensreg.eu/sites/default/files/CZ%20Temelin%20fact%20finding%20final.pdf SÚJB (2011). National Report on “Stress Tests” NPP Dukovany and NPP Temelin Czech Republic. Evaluation of Safety and Safety Margins in the Light of the Accident of the NPP Fukushima. http://www.ensreg.eu/node/369 SÚJB (2012). Post Fukushima National Action Plan (NAcP)on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic. http://www.ensreg.eu/node/695 UBA (2005). ETE Road Map – Item 7b Severe Accidents Related Issues, Final Monitoring Report, June 2005. http://www.umweltbundesamt.at/fileadmin/site/umweltthemen/kernenergie/temelin/Roadmap/PN7_FMR.pdf UBA (2006). Workshop with Plant Walkdown in Temelín, under the Czech-Austrian Bilateral Agreement, September 26/27, 2006. http://www.umweltbundesamt.at/fileadmin/site/umweltthemen/kernenergie/temelin/Roadmap/Walkdown_2006/ETEWalkdown2006.pdf
To be discussed	The implementation of a filtered venting system at ETE has not been decided yet. The topic will be analysed and strategy and schedule for implementation of measures for preservation of long-term containment integrity will be elaborated by the end of 2014. Further steps will depend on this strategy and schedule. (Regarding the connected issue of hydrogen removal, see Issue CZ 3.3.) The results of the analyses of this topic will make it possible to answer the following questions:

	- Which relevant alternatives for the protection of the containment against overpressure exist now? - What are the respective advantages and disadvantages of the different options? - Regarding filtered venting: Which retention factor would be required, what would be the requirements for long-term operation? - Which option(s) have been selected for implementation? - Which schedule has been selected for implementation? - How will safety be improved by the measures which are to be implemented? How does the original state of the NPP compare with the state after implementation of the measures? An appropriate time for the discussion would be about 2016, after the analyses have been completed, with a buffer time to allow for additional work which might be required. The analyses should be presented in detail (starting assumptions, scope, methodology, results) and the results evaluated, taking into account the questions listed above.
Safety importance	High
Expected schedule	Medium term
Follow-up	Dedicated presentation

Czech Republic	
Topic 3: Severe Accident Management	
Issue No	**CZ 3.3**
Title	Hydrogen management by passive autocatalytic recombiners for NPPs Temelín and Dukovany
Content	The decision to extend hydrogen management for severe accident conditions has already been taken for EDU and ETE. The existing hydrogen removal systems are intended for DBAs only. Installation of passive autocatalytic recombiners (PARs), as they are used in most PWRs in Europe, is foreseen at EDU. The plans for ETE are not specifically described in published documents. The deadline for implementation is 2015, for both plants.
Safety relevance	Hydrogen deflagration or detonation can lead to early containment failure, and to large, early releases. Compared to accidents with late containment failure, controlled containment venting or intact containment, this represents a severe accident with very high consequences. No sufficient time is available for implementing off-site emergency measures, and the releases would lead to wide-spread land contamination. Even without early containment failure, hydrogen deflagration can lead to damage inside the containment, for example impairing safety systems, which can make severe accident mitigation measures more difficult.
Background	The existing hydrogen removal systems at EDU and ETE are intended for DBAs only. For both plants, it is planned to extend the hydrogen management system for severe accident conditions. (For the connected Issue of containment venting, see Issue CZ 3.2.) The decisions for these measures were already taken before the Fukushima accident, as a consequence of the last PSRs (2006/7 for EDU, 2008/9 for ETE). According to the CZ **National Stresstest Report** (SÙJB 2011), at EDU, installation of about 30 passive autocatalytic recombiners (PARs) combined with igniters is planned which should, with functioning spray system, considerably reduce the hydrogen hazards (section II.6.3.2). Implementation is expected by 2015 (II.1.1.1). For ETE, only the general information that the hydrogen management system is to be improved is provided (section III.6.3.2); it is likely that PARs will be installed there as well. The deadline for the installation of PARs is not exactly specified (2015 to 2018) (III.1.1.1). In the **Czech Report to the 2nd Extraordinary CNS Meeting** (CR 2012), 2015 is given as deadline for EDU and 2018 for ETE (section 3.4). The CZ Stresstest **Peer Review Country Report** (ENSREG 2012a) does not report such definitive planning but states that the issue of installation of PARs for severe accidents is at present under investigation. The **National Action Plan** (SÙJB 2012) contains the following action for both NPPs: *Completion of projects of increase of the capacity of the system for hydrogen disposal during severe accidents* (action no. 46 for EDU, no. 47 for ETE). Deadline for completion is 2015 in both cases. Thus, the deadline for this measure at ETE has now been set three years earlier than envisaged before.

	References: CR (2012). Czech Republic – Extraordinary National Report under the Convention of Nuclear Safety, February 2012. http://www.sujb.cz/fileadmin/sujb/docs/zpravy/narodni_zpravy/CZ_NR_2012.pdf ENSREG (2012a). Peer review country report – Czech Republic. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/393 SÚJB (2011). National Report on "Stress Tests" NPP Dukovany and NPP Temelin Czech Republic. Evaluation of Safety and Safety Margins in the Light of the Accident of the NPP Fukushima. http://www.ensreg.eu/node/369 SÚJB (2012). Post Fukushima National Action Plan (NAcP)on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic. http://www.ensreg.eu/node/695
To be discussed	Questions which should be addressed in a presentation are: ➢ What is the basis for the capacity increase of the system for hydrogen removal? Which accident scenarios were considered, and which analyses were performed (methods, results)? ➢ Brief description of the new systems at EDU and ETE (number, type and location of PARs and – if applicable – other components). ➢ Current status of work and schedule for completion – is the deadline 2015 still valid? ➢ How will safety be improved by this measure? How does the original state of the NPPs compare with the state after implementation of the measure? The issue could be discussed before the capacity increase is completed since the measure will already have to be planned in detail when the actual implementation begins.
Safety importance	High
Expected schedule	Medium term
Follow-up	Dedicated presentation

Czech Republic	
Topic 3: Severe Accident Management	
Issue No	**CZ 3.4**
Title	Stabilization of molten core for NPP Temelín
Content	Core melt coolability and stabilization is an open issue for Temelín NPP. It is planned to perform analyses and propose a strategy for melt stabilization. A decision concerning the implementation of corresponding measures will be taken by the end of 2014; the further schedule is not clear yet. Until recently, stabilization of the molten core by cooling the vessel from the outside, as implemented for VVER-440s (see Issue CZ/HU/SK 3.1) was not regarded as feasible for reactors of the type VVER-1000, due to the relatively high thermal power. It was assumed that efforts had to focus on stabilization outside of the rector pressure vessel. According to new information provided in 2013, however, there is a new initiative to investigate in-vessel retention for ETE.
Safety relevance	The molten core can be stabilized inside the RPV, by external vessel cooling; or, after melt-through of the RPV, by cooling in the reactor cavity. The former option, however, appears to be better suited for smaller reactors. It is not clear whether it is also a realistic option for larger reactors, or whether larger reactors have to rely on stabilization outside the RPV. Without cooling and stabilization of the molten core, containment failure due to overpressure (if there is no venting capacity, see issue CZ 3.2) and/or basemat melt-through will occur, leading to significant radioactive releases.
Background	In the **National Stresstest Report** (SÙJB 2011), analyses concerning *localization of melt outside the RPV* are listed among opportunities to improve defence-in-depth. They are to be performed in the medium term, in cooperation with other operators of VVERs (table 36). The report also states that attempts of controlling the melt by flooding it with water are already part of the SAMGs (section III.6.2.3). Core melt coolability and stabilization outside of the RPV is an open issue for ETE, according to the Stresstest **Peer Review Country Report** (ENSREG 2012a, section 4.2.1.3). It is part of a preliminary list of SÚJB, for measures under consideration; it is not clear at the moment whether it will be among the measures which are selected for implementation (section 4.2.4.2). According to the **Czech Report to the 2nd Extraordinary CNS Meeting** (CR 2012), work on this issue is planned, to be completed 2018 (section 3.4). It is not clear whether this deadline refers to the completion of analyses, or already includes the implementation of possible measures resulting from these analyses. In the **National Action Plan** (SÙJB 2012), two actions refer to this issue, and the schedule is somewhat more specified: Action 49: *Implementation of analysis and propose a strategy and schedule for implementation of measures for preservation of long-term containment integrity (to stabilize melt and prevent overpressure)*. Action 50: *Implementation of measures for maintaining long-term containment integrity according to selected severe accident management strategies*. Both activities are listed as “in progress”; deadline for 49 is 2014, for 50 “according to schedule”. The latter clearly refers to the schedule which will be

	prepared in the course of action no 49. Hence, the schedule for implementation of measures is open. The meaning of the deadline of 2018 as given in the CNS report is not clear. At the Bilateral Meeting 2013, the Czech side provided new information. It was stated that there are new approaches for in-vessel retention (external cooling of the RPV) for larger reactors, in particular in South Korea. Thus, this might be an option for ETE after all. A feasibility study is on-going (Nuclear Research Institute Řež with international partners), evaluating international experience and performing analyses. The study is to be completed by the end of 2013 (BM A-CR 2013). References: BM A-CR 2013. Information provided during the discussions at the 22nd Czech-Austrian Bilateral Meeting, Langenlois, October 21/22, 2013 CR (2012). Czech Republic – Extraordinary National Report under the Convention of Nuclear Safety, February 2012. http://www.sujb.cz/fileadmin/sujb/docs/zpravy/narodni_zpravy/CZ_NR_2012.pdf ENSREG (2012a). Peer review country report – Czech Republic. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/393 SÚJB (2011). National Report on “Stress Tests” NPP Dukovany and NPP Temelin Czech Republic. Evaluation of Safety and Safety Margins in the Light of the Accident of the NPP Fukushima. http://www.ensreg.eu/node/369 SÚJB (2012). Post Fukushima National Action Plan (NAcP)on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic. http://www.ensreg.eu/node/695
To be discussed	Questions which should be addressed in a presentation are: ➢ What are the results of the feasibility study on in-vessel retention? In particular: Which accident scenarios were considered, which analyses performed (methods, results), what has been learned from international experience? Which further analyses have been performed for in-vessel retention? ➢ Which analyses have been performed concerning localisation of the melt outside the RPV – which accident scenarios were considered, which analyses were performed (methods, results)? ➢ What are the criteria for the selection of a strategy for melt stabilization? Which strategy has been proposed for implementation of measures on the basis of the analyses (measures planned, schedule)? ➢ How will safety be improved by this measure? How does the original state of the NPPs compare with the state after implementation of the measure? The appropriate time for a presentation would be after conclusion of the first phase (implementation of analysis and proposal of strategy and schedule), i.e. after 2014.

Safety importance	High
Expected schedule	Medium term
Follow-up	Dedicated presentation

Czech Republic	
Topic 3: Severe Accident Management	
Issue No	**CZ 3.5** ***(also important for other VVER countries)***
Title	Common VVER emergency support center
Content	There is an initiative by the Czech regulatory authority to incite the NPP operators of the Czech Republic, Hungary and Slovakia to establish a common VVER-440 operator center for mutual aid in case of a severe accident. This initiative was discussed during the Stresstest. However, it is not addressed in the Czech National Action Plan.
Safety relevance	The plants mentioned belong to the same reactor type (VVER-440/213) and also, to a considerable extent, have the same improvement measures planned or implemented. Thus, such a centre could be an effective measure to increase the emergency preparedness for severe accident management by off-site means.
Background	In the **National Stresstest Report** (SÙJB 2011), the regulatory authority announced that they will suggest to CEZ to consider the establishment of a common VVER-440 operator center for mutual aid in case of severe accident (including the NPPs Dukovany, Bohunice, Mochovce and Paks, for severe accidents (section IV.3.5). In the **Stresstest Peer Review Country Report** (ENSREG 2012a), this suggestion is mentioned and welcomed as a reasonable measure to increase the emergency preparedness for severe accident management by off-site means (section 4.2.4.1). This issue is not addressed in the **National Action Plan** (SÙJB 2012). The NAcP only contains a much more general point concerning participation of Czech experts in international programs (IAEA, OECD/NEA, WANO, EC-ENSREG, WENRA and bilateral cooperation), without specifically mentioning the common operator center (action 67). There are no indications as to the schedule for this measure. References: ENSREG (2012a). Peer review country report – Czech Republic. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/393 SÚJB (2011). National Report on “Stress Tests” NPP Dukovany and NPP Temelin Czech Republic. Evaluation of Safety and Safety Margins in the Light of the Accident of the NPP Fukushima. http://www.ensreg.eu/node/369 SÚJB (2012). Post Fukushima National Action Plan (NAcP)on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic. http://www.ensreg.eu/node/695

To be discussed	Questions which should be addressed in a presentation are: ➢ What is the status of the establishment of a common VVER-440 operator center for mutual aid in case of severe accidents (activities undertaken so far)? ➢ What will be the tasks of this center (regarding emergency preparedness, and in case of an accident), which capacities will it have? ➢ What is the schedule for complete establishment of this center? No information is available at the moment regarding the schedule for this measure.
Safety importance	Medium
Expected schedule	Long term
Follow-up	Dedicated presentation

Czech Republic	
Topic 3: Severe Accident Management	
Issue No	**CZ 3.6**
Title	Upgrade of PSA level 2, NPPs Dukovany and Temelín
Content	The probabilistic safety assessment (PSA) studies for EDU and ETE so far only include only full power operation in level 2. To better identify plant vulnerabilities, these studies at present are extended for low power and shutdown conditions. No deadline is provided for these activities.
Safety relevance	The significance of the overall results of PSAs (in particular, CDF and LRF) is rather limited, due to a number of factors which are inherent to PSAs and lead to considerable uncertainties in the results. Nevertheless, a PSA is a very useful tool to identify vulnerabilities in an NPP, as an important input for deciding on backfitting measures. It can also be helpful, although with high uncertainties, to quantify releases.
Background	According to the **National Stresstest Report** (SÙJB 2011), a level 2 PSA was performed for EDU in 1998 und later updated (2002 and 2006). This PSA includes only power operation. A PSA level 2 for low power and shutdown conditions is reported to be in the processing stage. It is not clear to which extent external events are considered in this new study (section II.1.1.4). For ETE, level 1 and 2 PSA were carried out 1993 – 1996 and updated in 2002-2003. The probabilistic models of the PSA are updated regularly as part of the Living PSA concept. The level 2 PSA currently includes only power operation. It is not clear to which extent external events are considered (section III.1.3). ENSREG recommendation 3.3.15 concerns level 2 PSA. The **National Action Plan** (SÙJB 2012) refers to this recommendation in action no. 69: *Upgrade PSA level 2 for both NPPs for the identification of plant vulnerabilities and quantification of potential releases related to extreme external conditions*. This activity is reported to be in progress. No deadline is provided. References: SÚJB (2011). National Report on “Stress Tests” NPP Dukovany and NPP Temelin Czech Republic. Evaluation of Safety and Safety Margins in the Light of the Accident of the NPP Fukushima. http://www.ensreg.eu/node/369 SÚJB (2012). Post Fukushima National Action Plan (NAcP)on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic. http://www.ensreg.eu/node/695

To be discussed	Questions which should be addressed in a presentation are: ➢ What is the scope of the on-going upgrade of the level 2 PSAs for EDU and ETE (which operational states are included, which external events)? ➢ When will results of the upgraded level 2 PSAs for EDU and ETE be available? ➢ Are there already intermediate results of the level 2 PSAs available? If so, can a summary be presented? What are the main new insights compared to earlier PSAs? No information is available at the moment regarding the schedule for this measure.
Safety importance	Medium
Expected schedule	Long term
Follow-up	Dedicated presentation

3.4 Topic X: Outside Topics 1 - 3

<table>
<tr><td colspan="2">Czech Republic</td></tr>
<tr><td colspan="2">Outside topics 1 – 3</td></tr>
<tr><td>Issue No</td><td>CZ X.1</td></tr>
<tr><td>Title</td><td>High energy pipelines of the secondary circuit at NPP Temelín</td></tr>
<tr><td>Content</td><td>In the course of the Melk-process follow-up, which concerned ETE 1+2, a number of issues were discussed extensively between Czech and Austrian experts in a series of expert workshops.
Most of these issues have been resolved so that no more open questions remained. However, regarding the high energy pipelines of the secondary circuit, some questions remained and additional information would be required by the Austrian experts for complete clarification.</td></tr>
<tr><td>Safety relevance</td><td>It is important to have adequate protection against the break of the high energy pipelines of the secondary circuit.
The purpose of the discussion during the Melk-process follow-up was to make sure that the safety case for these pipelines conforms to EU requirements and practice.</td></tr>
<tr><td>Background</td><td>The issue of the high energy pipelines of the secondary circuit (main steam and feedwater pipelines) was discussed in the course of the Melk-process follow-up. The last discussion took place in a dedicated workshop in March 2008.
A considerable amount of information was provided at this workshop, bringing an up-to-date overview regarding all issues for the Austrian experts. However, the Austrian experts could not completely follow the safety case for the high energy pipelines. Information regarding the following points would be required for complete clarification:
▪ Catalogue of load cases which were considered
▪ Details regarding the selection of possible locations of pipe breaks
▪ Details regarding the methodology and results of new stress calculations
▪ Information regarding the requirements for the application of the “No Break Zone” concept and justification of the application of this concept to the whole pipe system
It was agreed that the pertinent Bilateral Agreement is the appropriate framework for information exchange in the future.</td></tr>
<tr><td>To be discussed</td><td>New information regarding the four points listed above which has become available since 2008 would be of interest, as well as other information which might shed further light on the safety case of the high energy pipelines.</td></tr>
<tr><td>Safety importance</td><td>High</td></tr>
<tr><td>Expected schedule</td><td>Short term</td></tr>
<tr><td>Follow-up</td><td>Dedicated presentation</td></tr>
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Czech Republic	
Outside topics 1 – 3	
Issue No	**CZ X.2**
Title	Reactor pressure vessel integrity at NPP Temelín
Content	In the course of the Melk-process follow-up, which concerned ETE 1+2, a number of issues were discussed extensively between Czech and Austrian experts in a series of expert workshops. Most of these issues have been resolved so that no more open questions remained. This includes the issue of reactor pressure vessel integrity. However, the clarification of this issue, in 2008, was with the proviso that the results of the embrittlement surveillance program should be followed by the Austrian experts. New results from surveillance samples can be expected to be available by now.
Safety relevance	Guaranteeing the integrity of the reactor pressure vessel is of foremost importance since in case of vessel failure, core cooling cannot be provided by safety systems and a severe accident is likely.
Background	The issue of reactor pressure vessel integrity was clarified in the course of the Melk-process follow-up, in February 2008. According to the information provided to the Austrian experts, the chemical composition of base material and welds of the RPVs is favourable and lower embrittlement than known from other VVER-1000s can be expected. Clarification was with the proviso that the results of the surveillance program should be followed to make sure that the progress of embrittlement is as predicted. If the surveillance results confirm the expectations, no further activities are required. It was agreed that the pertinent Bilateral Agreement is the appropriate framework for information exchange in the future. New surveillance samples have been removed from the reactor pressure vessel 2008/2009 (unit 1 / unit 2); results of their evaluation should be available by now. According to plan, the next samples were to be removed 2012/2013.
To be discussed	The results of the evaluation of the surveillance samples from 2008/9 should be presented and compared to the expected development of the embrittlement. Also, the issue should be discussed at a time when results from the samples 2012/13 are already available.
Safety importance	Medium
Expected schedule	Medium term
Follow-up	Dedicated presentation