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Stress test Follow-Up Actions

Issue Paper for Slovenia

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1. Introduction

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

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

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 Stress test Follow-Up Action: Issues for Monitoring, Slovenia				
Issue	Title	Safety importance	Follow-up	
			Action	Schedule
TOPIC 1: Initiating Events				
SLO 1.1	Seismic hazard assessment	High	Dedicated workshop for topics SLO 1.1 to 1.5	4Q/2015
SLO 1.2	Paleoseismological evidence for a capable fault next to Krško	High	Dedicated workshop for topics SLO 1.1 to 1.5	4Q/2015
SLO 1.3	Geological assessment of the Krško II site	High	Dedicated workshop for topics SLO 1.1 to 1.5	4Q/2015
SLO 1.4	Assessment of soil-structure interaction and floor response spectra	High	Dedicated workshop for topics SLO 1.1 to 1.5	4Q/2015
SLO 1.5	Determination of safety margins of seismically qualified SSCs	High	Dedicated workshop for topics SLO 1.1 to 1.5	4Q/2015
SLO 1.6	Hazard assessment and design base for extreme weather conditions	Medium	Dedicated presentation	4Q/2016
TOPIC 2: Loss of Safety Systems				
SLO 2.1	Third seismically qualified and flood protected Diesel Generator	High	Dedicated presentation	4Q/2014
SLO 2.2	Provision of power to DC panels from portable generators	High	Check list	4Q/2014
SLO 2.3	Provision of connection of the 2000 kVA DG to the switchgear of the 3rd DG	Medium	Dedicated presentation	4Q/2014
SLO 2.4	Construction of a dedicated safety bunker, with dedicated water sources and HP safety injection pump, SG feed pump and containment spray pump	High	Dedicated workshop with SLO 2.5, SLO 2.8 and SLO 2.9	4Q/2017
SLO 2.5	Alternative ultimate heat sink (air cooled)	High	Dedicated workshop with SLO 2.4, SLO 2.8 and SLO 2.9	4Q/2017
SLO 2.6	Fire protection pumps for heat removal	Medium	Check list	4Q/2015
SLO 2.7	Quick connection points for mobile equipment and for power supply through the plant	High	Check list	4Q/2015
SLO 2.8	Alternate cooling of SFP	High	Dedicated workshop with SLO 2.4, SLO 2.5 and SLO 2.9	4Q/2017
SLO 2.9	Mobile heat exchanger	Medium	Dedicated workshop with SLO 2.4, SLO 2.5 and SLO 2.8	4Q/2017
TOPIC 3: Severe Accident Management				
SLO 3.1	Filtered containment venting	High	Dedicated presentation	4Q/2014
SLO 3.2	Hydrogen management by passive autocatalytic recombiners, and presence of hydrogen in unexpected places	High	Dedicated presentation	4Q/2014
SLO 3.3	Access to site by emergency staff	High	Dedicated presentation	4Q/2015
SLO 3.4	Emergency control room	High	Dedicated presentation	4Q/2015
SLO 3.5	Full scope PSA level 2	Medium	Dedicated presentation	4Q/2016

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

Slovenia	
Topic 1: Initiating Events	
Issue No	**SLO 1.1**
Title	Seismic hazard assessment
Content	The original design basis earthquake for Krško was determined with PGA=0.3g valid for the free-field. Subsequent PSHAs (1994, 2004) raised the level of seismic hazard to PGA=0.42g and finally PGA=0.56g for a non-exceedence probability 10^{-4} per year. The latest hazard assessment (PSHA 2004, PGA=0.56g) is challenged by a number of studies and international publications, which suggest still higher ground accelerations at the site. The Stress Tests documents further refer to several active faults, which were identified in the near-region of Krško. No information is provided whether or not the youngest fault slip histories have been determined by adequate studies and whether the results are included in the hazard assessment. A renewed discussion of the topic appears advisable at the background of ENSREG's suggestion to update hazard assessments and the design basis as frequent as necessary.
Safety relevance	Krško is located close to the high-seismicity plate boundary between the Adriatic and the European plate. Deformation at this plate boundary is distributed over a broad belt with numerous active faults, which extends into the vicinity of the NPP. Reliable seismic hazard assessments are of high importance given that the site is located in an area of high seismicity.
Background	Geological data, seismological evidence and hazard assessments published for the Krško region after 2004 claim peak ground values for occurrence probability 10^{-4} per year, which exceed PGAH=0.56g and may be not enveloped by the safety margins that have been determined for the NPP. Doubts about the validity of the PSHA 2004 results arise from several lines of seismological and geological evidence: 1. A critical discussion of the hazard assessments from 1994 and 2004 is provided by Sirovic et al. (2011) who take the position that the database used for the previous hazard assessments of the NPP is outdated. They point out that the maximum intensity that has been recorded at the Krško site reached up to the local intensity I=VIII (MSK-64 and EMS-98 intensity scales). As correlations between the ground acceleration and intensity are affected by large uncertainties, this intensity may correspond to ground accelerations of PGA≈0.3 to 1.0g. The authors conclude that the value of PGA=0.56g may have well been reached or even exceeded in historical times questioning the reliability of the PSHA, which addresses the non-exceedence probability of 10^{-4}/year.

	2. The reliability of the PSHA 2004 is further challenged by seismological data from the period between 1981 and 1989, which recorded a maximum ground motion of PGA=0.5g in the vicinity of the NPP. This ground motion occurred during an earthquake of magnitude M=3.9 (Fajfar et al., 2004). 3. Reading SNSA (2011) that both PSHAs, 1994 and 2004, are exclusively based on historical earthquake data, which only cover a short historical period. For the strongest earthquakes in Slovenia this period approximately covers the last 500 years. However, Herak et al. (2009) have shown that the completeness of earthquake records in the area is strongly limited. The following limitations apply to the Krško region: earthquakes with M≥3.6 are only complete since 1860, and earthquakes with M≥3.2 are only complete since 1950. These limitations result in very large uncertainties for long-term hazard assessments. Uncertainties are particularly high in regions where seismicity is governed by slow and very slow active faults moving at velocities of less than 1mm/y as is the case in the Krško region. Faults moving with 1mm/year produce earthquakes with M≥6 at recurrence intervals of several centuries. For a velocity of 0.1mm/year recurrence intervals increase to several thousands of years. These recurrence intervals exceed the available historical records by far, calling for the additional application of paleoseismological techniques to assess earthquake frequencies. 4. Seismotectonic models of the Krško region evolved dramatically in the years since the completion of the PSHA 2004. Newly developed models (e.g., Poljak et al., 2000; Vrabec and Fodor, 2006; Herak et al., 2009; Placer et al., 2010; Jamsek et al., 2011) show that active tectonics around the Krško Basin are governed by WNW- to NW-striking dextral strike-slip faults (Ravne-, Idria-, Periadriatic-, Lavanttal-, Drava fault etc.; Libna-fault in the Krško site vicinity), which produced numerous strong historical earthquakes (Ravne fault: Bovec, 1998, M=5.7 and Bovec, 2004, M=5.1; Idrija fault: Idrija Skovja Loka, 1511, M=6.9). Active thrust faults and folds such as the Sava folds in the Krško region and the Vodice fault near Ljubljana (Jamšek et al., 2011) extend between these dextral faults. A fault, which is kinematically comparable to the Vodice fault probably caused the earthquake of Ljubljana, 1895, M=6.1. Available geological data from the Sava folds in the Krško basin suggest that these structures may be comparable to the seismotectonic situation around Ljubljana (Persoglia et al., 2000; Gosar, A. & Božiček, B., 2006). Vrabec & Fodor (2006) showed that the folds result from the uplift of basement rocks at faults at the margins of the Krško basin. References: Fajfar, P., Lapajne, J., Herak, M., Hanson, K.L., Poljak, M., Poljanšek, K., Prelogović, E,. Swan, F.H., Šket Motnikar, B., Tomljenović, B., Youngs, R.R., Živčić, M., 2004. Revised PSHA for NPP Krško Site, PSR-NEK-2.7.2: Revision 1. Nuclear Power Plant Krško. Vrbina 12, Verlag University of Ljubljana, Faculty of Civil and Geodetic Engineering, Institute of Structural Engineering, Eartquake Engineering and Construction. Gosar, A. & Božiček, B., 2006. Structural maps of seismic horizons in the Krško basin. RMZ - Materials and Geoenvironment, Vol. 53, No. 3, 339-352. http://www.rmz-mg.com/letniki/rmz53/RMZ53_0339-0352.pdf Herak, D., Herak, M. & Tomljenovic, B., 2009. Seismicity and earthquake focal mechanisms in North-West Croatia. Tectonophysics, 465, 212-220.

	Jamšek P., Benedetti L., Bavec M., Atanackov J., Vrabec M. & Gosar, A., 2011. Preliminary report on the Vodice fault activity and its potential for seismic hazard in the Ljubljana Basin, Slovenia. 2nd INQUA-IGCP-567 International Workshop on Active Tectonics, Earthquake Geology, Archaeology and Engineering, Corinth, Greece (2011), 96-98. Persoglia, S., Gosar, A., Millahn, K., Nicolich, R., Nieto, D., Polj ak, M., Vesnaver, A., Wardell, N. (2000): Geophysical research in the surroundings of the Krško NPP. Final report. European Commission – PHARE, 68 pp. (unpublished report). http://www.gov.si/ursjv/en/por_pris/index.php?page=geonpp.php (Offline) Placer L., Vrabec M., and B. Celarc; 2010. The bases for understanding of the NW Dinarides and Istria Peninsula tectonics. Geologija, 53/1, 55-86. doi:10.5474/geologija. 2010.005. http://www.geologija-revija.si/dokument.aspx?id=1079 Poljak M., Živčič M. & Zupančič, P., 2000. The Seismotectonic Characteristics of Slovenia. Pure Appl. Geophys. 157, 37–55. Sirovich, L. Suhadolc, P., Costa, G. & Pettenati, F., 2011. A review of the seismotectonics of teh Krško plant area (SE Slovenia). 30° Convegno Gruppo Nazionale di Geofisica della Terra Solida GNGTS, Trieste, 14 –17 Novembre 2011, Abstract volume, 240-242. http://www2.ogs.trieste.it/gngts/gngts/convegniprecedenti/2011/riassunti/2.1/2.1_Sirovich.pdf SNSA (Slovenian Nuclear Safety Administration), 2011. Slovenian national report on nuclear stress tests, Fial Report, December 2011, 190pp. http://www.ensreg.eu/node/355 Vrabec M. & Fodor L.; 2006. Late Cenozoic tectonics of Slovenia: structura styles at the Northeastern corner of the Adriatic microplate. In: Pinter N., Grenerczy G., Weber J., Stein S., Medak D. The Adria microplate: GPS geodesy, tectonics and hazards, NATO Science Series, IV, Earth and Environmental Sciences, 61, Dordrecht: Springer, 151-168.
To be discussed	Discussion of seismic hazard issues should clarify whether new evidence from geologic and seismologic data that have been acquired after 2004 are in line with the assumptions and database of the PSHA 2004, or whether these data require an updated hazard assessment. Questions to be addressed in a thematic workshop include the following: ➢ Are the assumptions and results of the previous PSHA defendable against the seismological evidence of relatively high ground motion values that have been recorded in the region around Krško? ➢ What is the seismological database used for the PSHA 2004 and which assumptions have been made on the completeness of historical and instrumentally recorded data? Are these assumptions defendable against new seismological assessments? ➢ Stress Tests documents by SNSA (2011) indicate that some paleo-seismological investigations have been carried out in the site vicinity of the NPP. Has this research effort been embedded in a systematic approach to identify and map all potentially active faults in the site vicinity (<5km distance) and the near-region? What are the results of the paleoseismological investigations? If capable faults have been

	identified, how have they been integrated into the hazard model? ➢ Stress Tests documents by SNSA (2011) further state that several active faults have been identified in the near-region of the site. Have these faults been investigated systematically? What are the earthquake parameters that characterize the seismicity of these faults (maximum magnitude, recurrence interval, source characteristics etc.)? If such data are available, how have they been integrated into the hazard model? ➢ Are the novel seismotectonic models that describe regional tectonics (see citations above) in line with the assumptions made in the PSHA 2004? If not, how can they be integrated into an updated hazard model?
Safety importance	High
Safety priority	Medium term
Follow-up	Dedicated workshop for topics SLO 1.1 to 1.5

<table>
<tr><td colspan="2">Slovenia</td></tr>
<tr><td colspan="2">Topic 1: Initiating Events</td></tr>
<tr><td>Issue No</td><td>SLO 1.2</td></tr>
<tr><td>Title</td><td>Paleoseismological evidence for a capable fault in the vicinity of the Krško site</td></tr>
<tr><td>Content</td><td>Novel geological and paleoseismological data published by the Slovenian Regulator (SNSA 2013) have identified a number of faults within a short distance from the NPP Krško (e.g., Orllica, Artice, Stra Vas and Libna faults). At least part of these faults was assessed using a paleoseismological approach.

Paleoseismological trenching of the Libna fault confirmed that this fault is active and capable. The depth of research of the other faults appears unclear.

The Project team asks for information on the data obtained from the Libna fault, its structural relationship to the nearby faults, and the depth of research applied to the other near-site and near-regional faults.

Requested information should clarify the implications of this capable fault on the safety of the NPP.</td></tr>
<tr><td>Safety relevance</td><td>The paleoseismological proof of an active fault in the vicinity of the NPP Krško is of utmost importance for the safety of the installation.

The novel data need to be integrated into an updated seismic hazard assessment, and a probabilistic fault displacement hazard analysis (IAEA, 2010).</td></tr>
<tr><td>Background</td><td>Geotechnical, geological and seismological evaluations for the siting of a new NPP at Krško site revealed a series of novel evidences of an approximately NW-SE-striking fault zone in the site vicinity (Libna fault). The minimum distance between the existing NPP and the fault zone is less than 1km.

The Libna fault has consequently been the focus of paleoseismological surveys in the floodplain of the Sava river on the so-called Libna hill (about 1km N of the NPP). Work was executed by a consortium of geoscience institutes (BRGM, GeoZS, IRSN, ZAG).

Documents that have been published by SNSA (2013) indicate that paleoseismological trenching at the Sava floodplain confirmed the existence of the Libna fault. Although some evidence apparently suggested very young (Holocene) fault ages, no unequivocal data was revealed to constrain the age of the youngest fault activity.

Additional trenching at other locations (Libna hill) revealed evidence that Pliocene to Quaternary sediments are offset by the NW-SE-striking dextral strike-fault zone. The youngest unequivocally faulted sediments have been dated to ages between 210 and 130 thousand years by OSL and ESR age dating. Evidence of even younger fault displacement in pre-historic times (“Hallstadt Period”) and/or the formation of co-seismic features (soil-filled fissures) is favoured by some members of the paleoseismological consortium.

GZS (2011) therefore concludes that the Libna fault may be classified as a capable fault in the sense of IAEA (2010).

GZS (2011) further discusses the possibility that some of the disputed co-seismic deformation features at the Libna fault may have been triggered by seismic events that occurred on nearby faults (Orlica-, Artice-, Stra Vas fault). Data on the capability and the seismic activity of these faults as well as on other</td></tr>
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	faults in the site vicinity and near region are apparently not available. The documents published by GZS (2011) further show that: ➢ Some members of the GG&S consortium (e.g., BRGM) suggested additional geological, geomorphological and paleoseismological studies to better constrain the seismotectonic situation in the site vicinity. ➢ IRSN (2013) as a member of the GG&S consortium "considers that it is of utmost importance that the possible implications on the safety of the existing plant of this fault capability, as well as its potential structural relationship to nearby faults, be addressed without delay". ➢ Both suggestions appear highly reasonable considering the fact that the orientation and kinematics of the Libna fault is very well comparable to a number of active faults in the Slovenian territory, which proved capable and produced numerous strong historical earthquakes (i.e., the NW-striking dextral Ravne-, Idria-, Periadriatic-, Lavanttal-, Drava fault etc.). ➢ GEN energija (GEN) implemented a program for Probabilistic Fault Displacement Hazard Analysis (FDPHA) to assess the impact of the Libna fault on the safety of the existing facility and the sites envisaged for Krško II. References: BRGM, 2013. Letter to GEN energija, d.o.o., February 19th, 2013. http://www.ursjv.gov.si/fileadmin/ujv.gov.si/pageuploads/si/medijsko-sredisce/dopisGen/p9.pdf GZS (Geoloski Zavod Slovenije), 2011. Geotechnical, Geological and Seismological (GG&S) Evaluations for the New Nuclear Power Plant at the Krško Site (NPP Krško II). Paleoseismological Trenches on the Libna Hill. Revision 1, UUBUANA, April 2011 (unpublished report). 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 IRSN, 2013. Letter to GEN energija, d.o.o., January 9th, 2013. http://www.ursjv.gov.si/fileadmin/ujv.gov.si/pageuploads/si/medijsko-sredisce/dopisGen/p1.pdf SNSA (Slovenian Nuclear Safety Administration), 2013. URSJV se je seznanila z mnenjem francoskega inštituta IRSN o potresni varnosti lokacije Krško, 15.3.2013. http://www.ursjv.gov.si/si/info/novica/article/4597/5735/b59f6ae1b52b804f4376d3e3298a1bfe/
To be discussed	The objective of the requested discussion is to obtain more information on the highly safety relevant faults in the site vicinity and near region of the Krško site: ➢ Documents published by SNSA (2013) only include the paleoseismological assessments by Geoloski Zavod Slovenije, which discuss several possible interpretations of the paleoseismological findings. Is their assessment ("the Libna fault *may be* described as capable") supported by other international experts involved in the project, e.g., Daniela Pantosti? ➢ What kind of paleoseismological data is available from the other

	potentially active faults mentioned in the SNA (2013) documents, i.e., the Orlica-, Artice- and Stra Vas fault? ➢ What is the database of the Probabilistic Fault Displacement Hazard Analysis (FDPHA)? Are data sufficient to describe the direction, extent, history, and slip velocity of the faults as well as the age of the most recent movement, as required by IAEA (2010)? What are the key assumptions made in this analysis, and what are the results of the assessment? ➢ What kind of additional analyses are planned to assess capability and seismic potential of the Libna fault and other potentially active faults in Krško's site vicinity and near region? Background: When a capable fault is known or suspected to be present, IAEA (2010) suggests very detailed "geological and geomorphological mapping, topographical analyses, geophysical surveys (including geodesy, if necessary), trenching, boreholes, age dating of sediments or faulted rock, local seismological investigations and any other appropriate techniques to ascertain the amount and age of previous displacements". ➢ What measures have been decided to implement the recent findings into an updated seismic hazard assessment for the existing NPP? ➢ What is the Regulator's current assessment of the new data with respect to the seismic hazard of the NPP Krško?
Safety importance	High
Safety priority	Medium term
Follow-up	Dedicated workshop for topics SLO 1.1 to 1.5

Slovenia	
Topic 1: Initiating Events	
Issue No	**SLO 1.3**
Title	Geological assessment of the Krško II site
Content	Recent geotechnical, geological and seismological investigations at the Krško II site identified a number of faults within the radius of 5 km from the site, which were assessed with respect to their capability (e.g., Orllica, Artice, Stra Vas and Libna faults). The Slovenian Regulator has published information indicating that paleoseismological data from the Libna fault led to the conclusion that this fault is categorized as a capable fault. The depth of research of the other faults appears unclear. Published information shows that the findings obtained from the Libna fault have raised heavy concerns about the suitability of the Krško II site that is envisaged for the implementation of a new nuclear power plant. The Project team asks for information about the impact of these findings on the siting process for Krško II.
Safety relevance	A site should be deemed unsuitable for the implementation of a nuclear installation upon the identification of capable faults according to IAEA and US NRC (Regulatory Guide 4.7) recommendations. The IAEA requirements document, NS-R-3, section 3.7 states “where reliable evidence shows the existence of a capable fault that has the potential to affect the safety of the nuclear installation, an alternative site shall be considered”. The guidance document SSG-9 recommends (indirectly) to rule out surface faulting in a radius of 5km or site vicinity area. IAEA therefore recommends not to construct a nuclear installation within 5km.
Background	See SLO 1.2. References: IAEA (2003): Site evaluation for Nuclear Installations. Safety Requirements, No. NS-R-3, Vienna 2003. http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1177_web.pdf 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 U.S. NRC (1998). Regulatory Guide 4.7 – General Site Suitability Criteria for Nuclear Power Stations. http://www.nrc.gov/reading-rm/doc-collections/reg-guides/environmental-siting/rg/04-007/
To be discussed	In addition to the information requested in issue SLO 1.2 the Project team requests the following information: ➢ How does SNSA currently assess the capable fault issue? ➢ What is the current status of the siting process for Krško II?
Safety importance	High
Safety priority	Short term
Follow-up	Dedicated workshop for topics SLO 1.1 to 1.5

Slovenia	
Topic 1: Initiating Events	
Issue No	**SLO 1.4**
Title	Assessment of Soil-Structure Interaction (SSI) and floor response spectra
Content	Probabilistic seismic hazard assessments performed in 1994 and 2004 raised the level of seismic hazard to PGA=0.56g (occurrence probability 10^{-4} per year), which is nearly twice the original SSE (safe shutdown earthquake) acceleration of 0.3g. The new assessments, however, did not lead to an update of the seismic design basis. The ENSREG Country Report consequently refrains from confirming the adequacy of the design base. From an updated model for soil-structure interaction, it was concluded that the peaks in the floor response spectra, which correspond to the PGA of 0.56g in the free field, are similar to those obtained in the original design. This finding is used to claim that the Krško NPP can accommodate a ground motion of much higher intensity than it was designed for. The new assessments of soil-structure interactions and floor response spectra are not sufficiently described in the Stress Tests documents. The Project team therefore asks for information justifying that the newly derived floor accelerations for the free field ground motion PGA=0.56g do not exceed the floor acceleration values derived for the original design base event of PGA=0.30g.
Safety relevance	Demonstration of the seismic safety of the NPP in the Stress Tests documents relies on the argument that the original design for PGA=0.3g is highly conservative due to the assumptions made in the original design for the soil-structure interaction and floor response spectra. It is said that “additional analyses and more advanced realistic models” for soil-structure interaction led to the conclusion that the peaks in floor response spectra correspond to a free-field ground motion of PGA=0.6g (instead of the original value PGA=0.3g). The reliability of the modelling process that led to that conclusion, and the correctness of the new data, assumptions and estimates used for the modelling is indispensable for demonstrating that the seismic resistance of the NPP envelopes the updated SSE.
Background	During the Stress Tests it was explained that the seismic analysis of safety classified SSCs was performed by dynamic analyses using a time history method on a modal model (SNA, 2011). The soil structure interaction is considered in this model since the PGA determined for the design basis earthquake by seismic hazard assessment is valid for free field only and not for the foundation level or the floor response. Seismic modelling of the safety classified SSCs (seismic category 1 structures, mechanical components and systems) uses a complex mathematical modal analysis time history method. SNSA (2011) notes that soil-structure interaction is modelled by spring models which use a number of estimates and assumptions on soil properties. During the Stress Tests it was further explained that details of the models are described in USAR (Updated Safety Analysis

	Report) 3.7 and associated references. The Austrian side currently has no information about details of SSI modelling approach, its methodology, and the basic assumptions and input data. References: SNSA (Slovenian Nuclear Safety Administration), 2011. Slovenian national report on nuclear stress tests, Final Report, December 2011, 190pp. http://www.ensreg.eu/node/355
To be discussed	The proposed workshop should allow for discussion of the following issues: ➢ What are the differences between the original SSI model in the original design and the updated model? Are the different assumptions justified by new site-specific data? ➢ What kind of novel data (e.g., on soil characterization) are available to support the updated model? ➢ How was the material and damping in the soil modelled in the SSI-analyses? ➢ How have the floor response spectra been derived? The Project team further asks for access to the report USAR (Updated Safety Analysis Report) 3.7 and associated references to prepare for a focused discussion.
Safety importance	High
Safety priority	Medium term
Follow-up	Dedicated workshop for topics SLO 1.1 to 1.5

Slovenia	
Topic 1: Initiating Events	
Issue No	**SLO 1.5**
Title	Determination of safety margins of seismically qualified SSCs
Content	Analysis of safety margins for critical safety functions of the NPP Krško claim significant margins for seismic category 1 SSCs. Accordingly, a PGA in the range of 0.80g or higher would be likely to cause core damage. At this seismic level, the critical induced sequence is an Anticipated Transient Without Scram (ATWS) with station black out conditions. Information provided in SNSA (2011), however, does not clearly specify the methodology used for assessing the fragility of the safety classified SSCs, which are necessary to ensure functionality of the safety functions. It is therefore not fully clear how the determined safety margins were derived.
Safety relevance	Seismic hazard at the Krško site is significantly higher than the original design base of the plant. Updated and increased hazard levels, however, did not lead to a change of the design base. Since it is claimed that the determined safety margins are sufficient to withstand the new ground motion hazard it is highly important that these margins are reliable.
Background	Repeated seismic hazard assessments for the Krško site led to a significant stepwise increase of the severity of the safe shutdown earthquake (SSE) from PGA=0.3g (original design basis) to PGA=0.56g, where both values describe free-field ground motion. During the Stress Tests it was claimed that this considerably higher value of ground motion is still enveloped by the significant seismic safety margins that are available for all seismically qualified SSCs. The published Stress Tests documents (SNSA, 2011) are not very specific in explaining the process and methodology used for seismic margin assessment. During the discussions at Luxembourg and during the Stress Tests Country Visit some explanation has been added, which, however, is not accessible for the Austrian side. It was explained that: ➢ The assessment used High Confidence of Low Probability of Failure (HCLPF) values defined in terms of PGA. Analyses defined the value at which the induced failure probability of an SSC under consideration is lower than 5% according to the 95% confidence fragility curve. The report ESD-TR-08/11 was cited for details. ➢ The seismic margins were determined in fragility analysis performed by ABS (Reports SPSA-ABS-NEK-2004 and ESD TR 08/11). ➢ Evidence that the Krško NPP can accommodate a PGA of 0.6g is documented as part of the response to the first PSHA (with a reference to the EQE report "Probabilistic Seismic Response Analysis for NPP Krško", no. 52177-R-001). ➢ The NPP performed several modifications and “small corrections” that

	support NPP earthquake resistance (SNSA, 2011, p.33).
To be discussed	In addition to the information requested in issue SLO 1.4 the Project team requests the following information: ➢ Seismic margin evaluations are performed by HCLPF for different PGA ranges (PGA<0.15g, 0.15g<PGA<0.30g etc.). Do these values refer to the free field ground motion or to the seismic load of the SSCs as built (at their location within the NPP, i.e., is a lower peak acceleration of the specific SSCs assumed, due to soil-structure interaction and floor response spectra)? ➢ If soil-structure interaction and floor response spectra are considered: what is the uncertainty related to the introduction of these parameters? ➢ What kind of data, assumptions, and methods are used for seismic modelling of the different SSCs, and what are the results of these assessments? ➢ What retrofitting efforts have previously been undertaken to strengthen the earthquake resistance of the NPP? ➢ SNA (2011, p. 33-34) lists several back-fitting measures to further increase the NPP's earthquake resistance. Are any additional modifications foreseen? References: SNSA (Slovenian Nuclear Safety Administration), 2011. Slovenian national report on nuclear stress tests, Final Report, December 2011, 190pp. http://www.ensreg.eu/node/355
Safety importance	High
Safety priority	Medium term
Follow-up	Dedicated workshop for topics SLO 1.1 to 1.5

Slovenia	
Topic 1: Initiating Events	
Issue No	**SLO 1.6**
Title	Hazard assessment and design base for extreme weather conditions
Content	Stress Tests documents provided by SNSA (2011) do not mention reference documents or standards used for the definition of the design basis, nor PSRs specific to bad weather conditions. The Slovenian National Report only refers to maximum and minimum historical values and does not describe the potential combination of extreme weather conditions. The National Report further claims that structures that house and protect all safety equipment are designed to withstand severe weather conditions that could occur at the site. However, no detail is provided regarding the design value for extreme weather conditions.
Safety relevance	Natural hazards resulting from severe weather conditions shall be part of the design of a nuclear installation.
Background	The Stress Tests Documents by SNSA (2011) do not contain a chapter specific for hazards due to extreme weather conditions. ENSREG (2012) states that SNA (2011): ➢ Does not mention reference documents or standards used for the definition of the design. ➢ Only gives maximum and minimum historical values of severe weather conditions, potential combinations of weather conditions are not described. ➢ Does not provide details regarding the design value for extreme weather conditions. ➢ Does not provide technical background for requirements for extreme weather conditions. ENSREG (2012) concludes that “No strong evidence can be found in the Slovenian National Report to show that the Krško NPP complies with the design basis”. It is, however, stated that some information on the assessment, design base and protection against extreme weather conditions was provided during the Country Visit. References: SNSA (Slovenian Nuclear Safety Administration), 2011. Slovenian national report on nuclear stress tests, Final Report, December 2011, 190pp. http://www.ensreg.eu/node/355 ENSREG, 2012. Slovenia. Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/403

To be presented	The Project team asks for the following information to clarify the issue: ➢ National requirements and standards applicable to natural hazards due to extreme weather conditions. ➢ Information on the design basis values for extreme weather conditions. ➢ Details on the database and methodology used to assess extreme meteorological events. ➢ Evidence that the Krško NPP complies with the design basis with respect to extreme weather conditions.
Safety importance	Medium
Safety priority	Medium term
Follow up	Dedicated presentation

3.2 Topic 2: Loss of Safety Systems

Slovenia	
Topic 2: Loss of safety systems	
Issue No	**SLO 2.1**
Title	Third seismically qualified and flood protected Diesel Generator
Content	Procurement, installation and commissioning of the third emergency diesel generator, located in a separate building, on the opposite side of the containment from the existing DGs, powering the third safety bus that could be connected to provide rated power to either one of existing safety busses.
Safety relevance	Regardless of having two independent off site power supply lines (plus a dedicated line to Brestanica gas plant) Krško NPP, having only two diesel generators, is highly vulnerable in the LOOP sequences. In particular, both of the existing DGs are located in the same area, making them vulnerable to external events including aircraft crash. This vulnerability was recognised long time ago in the Krško PSA study, and confirmed in the first PSR in 2003. While planned before Fukushima, the design of the third DG has been modified to reflect the lessons learned (to assure additional flood protection and to enable multiple combinations of connections and loads to be supplied). The new DG has been installed and commissioned in 2012, and recognised as such in plant documentation.
Background	A project “Integrated Safety Assessment of NPP Krško Modernization” developed an updated PSA model for use in the evaluation of risk. A seismic PSA model developed/improved as part of the ISA was used to identify potential modifications to systems and to procedures that could result in cost-effective risk reduction. A few potential modifications were initially identified for evaluation: ➢ Small 0.6 kVA portable 400 V diesel generator (risk reduction depends strongly on time); ➢ Condensate storage tank (CST) alternatives: build basin around CST, water tank truck; ➢ Enable feed and bleed (N2 tanks for valves); ➢ ESW alternative; ➢ Addition of a third main 6.3 kV diesel generator; ➢ DC powered let-down and reactor coolant pump (RCP) seal return isolation valves. At the end addition of a third main 6.3 kV diesel generator was chosen for implementation, having significant impact on plant seismic risk and also impact internal initiating event CDF. Around 35% reduction of total CDF was expected. The most important systems with respect to core damage prevention are AFW and emergency diesel generators. This is in accordance with the high importance of the secondary heat sink function and with the high contribution of LOOP and SBO initiators to core damage probability at Krško. In case of loss of the primary heat sink, combined with SBO, for the alternative

	power supply one of two alternative diesel generators could be used. Those are located on the highest ground elevation, and are safe in case of flooding. Those diesels provide electrical power only to selected essential consumers (Emergency lighting, PDP).The current/power on cables from these diesel generators is limited to the 574 A/400 kVA. The operation of the new EDG is credited at seismic levels up to 0.80 g. Seismic failure of EDGs is considered likely at 0.85 g, probability ≤ 10%. Seismic events at which late radioactivity releases into the environment would be likely to occur are considered to be of PGA in the range of 0.8 g or higher. Core damage is considered likely at this range of seismic events. It would occur under conditions where it is to be expected that neither EDGs nor ESW/CCW would be available. This would, in turn, mean that containment heat removal functions (RCFC or CI/LP ECCS) are not available. However, it needs to be pointed out that there would still be strategies for controlling containment conditions, defined in SAMGs. Those strategies would ensure that any release to the environment is limited. With the installation of the filtered vent system, the releases are expected to be scrubbed and planned. References: ENSREG, 2012. Slovenia. Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/403 SNSA (Slovenian Nuclear Safety Administration), 2011. Slovenian national report on nuclear stress tests, Final Report, December 2011, 190pp. http://www.ensreg.eu/node/355
To be discussed	The presentation should describe in more detail the safety concept and design of the implemented measure and answer the following questions: ➢ What is the level of seismic qualification for the 3rd EDG? ➢ What modifications where implemented following lessons learned from Fukushima to the originally envisaged design for the third EDG? ➢ What is the level of resistance to other external events (natural and human-made) of the 3rd EDG, including in particular flooding? ➢ Which considerations are given to the operation (the line-up of the DG to the safety train 1 or 2 needs to be done by hand from within the DG building) of the third EDG in a case of a large scale damage at the site (i.e. aircraft crash) or site flooding?
Safety importance	High
Schedule	Short term
Follow-up	Dedicated presentation

Slovenia	
Topic 2: Loss of safety systems	
Issue No	**SLO 2.2**
Title	Provision of power to DC panels from portable generators
Content	Acquisition of two portable petrol engine driven 125 V generators that could be connected to the main DC distribution panels A and B, to supply selected DC loads in a case of loss of DC power. Appropriate connections and breakers/switches as well as the procedures are provided.
Safety relevance	Krško DC loads are battery supported. With the full load, the batteries could be depleted in about 4 or so hours. As all of the instrumentation, lighting and some of the controls are DC powered, loss of batteries would lead to lack of information on the plant status and thus inability to control some of the equipment at the plant. In the absence of the voltage to main safety busses (the SBO sequence), these portable generators could charge the batteries and/or supply the DC loads, by connecting directly to the battery busses.
Background	The Krško NPP is connected to the national 400 kV grid by 3 power lines, and with one connection to the 110 kV system. Krško NPP is also connected with a dedicated 110 kV line to the gas power plant (GPP) Brestanica. Two unit transformers provide normal on-site power supply for two Class 1E (MD1 and MD2) and two Non-1E (M1 and M2) 6.3 kV buses. Each 6.3 kV bus is powered from its respective 3.5 MW EDG. Each Class 1E train is provided with a 125 V DC train. Each train's system consists of a full capacity 125 V DC lead-acid 60 cell battery, with the capacity of 2080 Ah. The batteries are sized to supply DC loads for four hours with a final discharge to 108 V (1.80 V per cell). The batteries have sufficient capacity per design to cope with a 4-hour station blackout (loss of all AC power), to provide safe shutdown of the unit. Establishing alternative power supply to the DC distribution panel and to the instrumentation distribution panels from portable diesel generators would assure long(er) availability of DC powered consumers as well as of 118 V AC instrumentation power supply (up to 72 hours with the fuel stored at the plant, or even longer if fuel would be supplied from offsite). References: SNSA (Slovenian Nuclear Safety Administration), 2011. Slovenian national report on nuclear stress tests, Final Report, December 2011, 190pp. http://www.ensreg.eu/node/355
To be discussed	The issues of interest include: ➢ What was the basis for selecting the power for those portable generators? ➢ How long would it take to connect them to the battery busses, is there a dedicated (emergency) operating procedure for the connection/operation and whether/when was this tested? ➢ Where are the connection points and how is the access to those assured in a case of a large-scale destruction/flooding on the site?

Safety importance	High
Schedule	Short term
Follow-up	Check list

Slovenia	
Topic 2: Loss of safety systems	
Issue No	**SLO 2.3**
Title	Provision of connection of the 2000 kVA DG to the switchgear of the 3rd DG
Content	Krško already possess (NEEDS TO BE VERIFIED) a non-safety class 2000 kVA DG that has been acquired to support the operation of the plant's switchyard. A connection that could be activated in case of failure of other sources of power will enable use of this DG in emergencies. It is proposed that this DG is connected to the switchgear of the third DG, to supply any of the safety busses.
Safety relevance	As this DG is physically distant to the plant and the other DGs, it might remain available in a case of large scale destruction (e.g. aircraft crash). Therefore, if the connection exists, the power supply could be assured to the plant's safety systems. The issue is the separation between safety and non-safety systems.
Background	The Krško NPP implemented (completion planned for 2012) additional safety upgrades, in particular: a third independent DG 6.3 kV (in a separate building with a separate switchgear, enabling the power to be directed to any one of the main safety buses); connection of 2000 kVA DG to switch gear of third DG. The 2000 kVA DG is acquired for the provision of power supply to the switchyards (plant's own, and neighbouring distribution switchyard of the national grid operator). While it is not safety-related nor qualified, it represents an additional power source that would be available in cases when the other on-site sources are lost. An advantage is that the location of this DG is distant to the plant itself (of particular relevance in a case of an aircraft crash), while a disadvantage is that it shall be manually started/connected to the plant's distribution system, as well as the fact that there shall be load shedding on safety busses due to a lower capacity of the DG. The most appropriate connection point between this DG and the plant is the switchgear of the third DG, which would enable the connection to any of the plant's safety busses, thus supplying most important safety equipment. References: ENSREG, 2012. Slovenia. Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/403
To be discussed	The presentation should describe in more detail the safety concept and design of the implemented measure and answer the following questions: ➢ What is the safety effect (i.e. in a SBO sequence) of adding this DG? ➢ How is the connection being implemented? ➢ Has the procedure of starting and connecting this DG to each safety bus been verified? Has it been tested how much time it takes? ➢ How is the load shedding to protect this DG from overload being organised, and which loads are selected as essential ones? Has this operation been tested and verified?

Safety importance	Medium
Schedule	Short term
Follow-up	Dedicated presentation

Slovenia	
Topic 2: Loss of safety systems (and Topic 3, severe accidents for CS pump)	
Issue No	**SLO 2.4**
Title	Construction of a dedicated safety bunker, with dedicated water sources and HP safety injection pump, SG feed pump and containment spray pump.
Content	An additional high pressure pump to be used to inject water in the RCS, feed pump for SGs and containment spray pump for spraying and flooding the containment are planned. All those are to be located in a bunker to be protected against external events (2×SSE and PMF flood protected). The pumps will have their own reservoir of borated water for 8 hours (not clear on which flow rate), with a possibility to be refilled by mobile equipment.
Safety relevance	At present, Krško does not possess any bunkered systems. In case of major damage of the plant's auxiliary building(s) and surrounding areas (e.g. SW pump house, RWS tanks, etc.), the RCS injection, SG injection or the containment spray might become unavailable, leading to a core damage/release sequence. A bunkered building, protected against natural and human made hazards, with dedicated pumps and source of water will help maintain the inventory and/or cool the fuel in the RPV and allow for the secondary heat removal. In case when the CS spray pumps are not available, the additional containment spray pump will allow for the spray to protect the integrity of the containment in the case of LOCA. Furthermore, in the case of core damage with RPV failure, this pump is expected to be used to flood the containment, thus helping prevent e.g. MCCI or DHC and assuring the integrity of the containment and prevention of release of radioactive products in the environment.
Background	After the Fukushima accident, Krško NPP performed an initial quick review to identify possible short term improvements. In June 2011, a series of minor modifications to the plant were licensed to add alternative possibilities for electrical power supply and cooling of the reactor and SFP in the event of BDBA, and were under implementation at the time the Slovenian National report was being written, to increase the plant's capability to withstand extreme external hazards. Those include mobile pumps and power sources but also the dedicated connection points for those. In response to the Fukushima accident, the regulator issued a decision requiring the Krško NPP to perform a Special Safety Review (the program in line with the ENSREG specifications for Stress Tests). In September 2011, the regulator issued a decision requiring the plant to reassess the SAM strategy, as well as existing measures to implement necessary safety improvements for the prevention of an SA and the mitigation of its consequences. In January 2012, Krško NPP presented the analysis and action plan, this then being reviewed and approved by the regulator. The action plan, expected to be implemented by the end of 2016, comprises the following measures: – *Realisation of an additional third train of engineered safety features comprising the already mentioned third DG, MD bus, a high-pressure safety-injection pump and a feed-water pump. This train will be located in the already constructed building protected against external events.* – Alternative UHS, – Installation of a special emergency control room, to be located in the

	above mentioned new building, – Alternative means of cooling the SFP and of decay-heat removal, – Filtered containment venting, – Passive autocatalytic recombiners for hydrogen control in the containment, – A new TSC with enhanced habitability requirements. With regard to the prevention of severe accidents and also severe accident management, the Slovenian National Report describes that the most effective means to protect containment integrity during SBO and loss of ultimate heat sink is spraying the containment atmosphere with alternative portable fire protection pumps (or fire truck), which can also effectively use RCP fire protection spray nozzles beside normal containment spray lines. By doing this, containment will not fail within 7 days. Possible means of injecting water into the containment are: containment spray pumps, gravity feed from RWST to containment sump, ECCS and the reactor coolant system break as it is addressed in SAG-3 (Inject into the RCS) and portable fire protection pumps. Injection flow-paths are through containment spray header using containment spray pumps or portable fire protection pumps, gravity feed through recirculation spray or ECCS lines to the containment sump (it is possible to provide power to the sump isolation valves by portable diesel generators), through fire protection lines for spraying reactor coolant pump and through ECCS. Portable fire protection pumps are stored on-site with fuel supply available for three days of operation. Fire protection truck is available on-site as well. There is a variety of suction sources for injecting water into containment: fire protection tank, water treatment tanks, pre-treated water tanks, condenser hot well, city water, circulating water tunnel, and the Sava river water. Of all the safety improvements implemented or planned, the safety bunker, containing 3 pumps and dedicated sources of water is the most important as it adds a new level of protection of the plant. However, while the general concept is presented, the details of the design and implementation, including the resistance to human-made and external events, location of the bunker (as for the distance to the plant), sizing of the equipment, connection to the plant, power supply and I&C, control points and connections for resupply are all not yet available. References: ENSREG, 2012. Slovenia. Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/403 SNSA (Slovenian Nuclear Safety Administration), 2011. Slovenian national report on nuclear stress tests, Final Report, December 2011, 190pp. http://www.ensreg.eu/node/355

To be discussed	In the thematic workshop the Slovenian side is expected to provide a comprehensive presentation on the design basis and the design solution for the bunker system and its equipment. The following issues are of interest: ➢ The design basis for the bunker and its equipment (seismic resistance, other external hazards, spectrum of sequences to be protected against). ➢ Access to the bunker in normal operation and emergencies. ➢ Sizing of the equipment in the bunker. ➢ Location of the bunker and connections with the plants systems (where will the bunker be located, how is the connection assured not to interfere with current systems- maintain the separation- while assuring that the functions of the bunker are fulfilled when needed). ➢ Supply of power to the bunker (it is planned that the bunker is supplied from new 3rd DG). How was the power supply level established (as the 3rd DG was not originally planned to supply the bunker). How will the supply be installed (underground cable, manual or automatic). ➢ I&C, control of the bunker and the conduct of operation (automatic or manual). Which interventions are needed to have the bunker in operation. ➢ Dedicated water sources: on which basis (sequences, assumptions) have the water supply needs been estimated and which sequences are covered. How will the resupply be assured. ➢ Schedule for design, implementation and licencing
Safety importance	High
Schedule	Long term
Follow-up	Dedicated workshop together with SLO 2.5. 2.8 and 2.9

Slovenia	
Topic 2: Loss of safety systems	
Issue No	**SLO 2.5**
Title	Alternative ultimate heat sink (air cooled)
Content	Krško NPP needs an alternative ultimate heat sink to dissipate the heat in case the main heat sink (Sava river) is unavailable. While some plants in Europe (mostly those located close to rivers, or having a porous terrain) rely on dedicated water wells on a site, Krško is considering installing a dedicated safety related cooling tower. In such a case the atmosphere will become the ultimate heat sink. This cooling tower shall be seismically proof and flood protected and located at a distance from the main heat sink (SW pump house at Sava river). The technical solution, location or the connection of this systems (e.g. to the SW heat exchanger or directly to the CC) are not known.
Safety relevance	With a single ultimate heat sink constituted by the 2 trains service water system and Sava river, Krško is rather vulnerable to any physical destruction (but also to flooding, other external hazards) of those. An alternate and diversified heat sink will allow for a controlled cooling of the reactor and maintaining it in a cold shutdown state even with the main heat sneak not being available. This removes a significant vulnerability of Krško original design.
Background	In the Slovenian **National Stress Test Report** a solution/measure is identified for improving plant resistance to loss of ultimate heat sink concurrent with SBO: *New water line from Krško HPP could provide alternative way of cooling the component cooling heat exchanger by a passive means.* The Country Peer Review Report [2] states that a new alternative UHS, totally separate from the Sava River, is under consideration, and this will be seismically-qualified, probably a cooling tower. This alternative UHS was, at the time of the peer review, at the study phase. References: ENSREG, 2012. Slovenia. Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/403 SNSA (Slovenian Nuclear Safety Administration), 2011. Slovenian national report on nuclear stress tests, Final Report, December 2011, 190pp. http://www.ensreg.eu/node/355
To be discussed	While the vulnerability is well understood, the measures planned for the remediation of that vulnerability are not known. It is proposed that in the workshop (where also other safety improvements are to be discussed) the details of the solution proposed (that being the dedicated cooling towers or other means) are discussed. Of interest are: ➢ Design concept, the design basis for the new UHS. ➢ Alternatives considered and the basis of the solution selected. ➢ Sequences for which the UHS is designed; survivability during external hazards. ➢ Integration of the new ultimate heat sink with the plant, connection

	points, instrumentation and operation. ➢ Power supply; water replenishment (as appropriate). ➢ Schedule for design, implementation and licencing.
Safety importance	High
Schedule	Long term
Follow-up	Dedicated workshop together with SLO 2.4, 2.8 and 2.9

Slovenia	
Topic 2: Loss of safety systems	
Issue No	**SLO 2.6**
Title	Fire protection pumps for heat removal
Content	Krško intends to acquire two high pressure mobile fire protection pumps to be used for removal of the decay heat in the early stage after reactor shutdown, after depressurizing steam generators. It is understood that those pumps will have a connection to feed the secondary side of the steam generators. Those pumps seem to be additional to the already-acquired "HFS HydroSub 450 floating unit", of 720m^3/h (a part of the “mobile water ring”), that could be used to remove the heat from the SGs or from the SFP.
Safety relevance	This an additional alternative for the heat removal by pumping water (that could also be the river water or any other water source) into the SG and removing heat by steaming off. In case of a total loss of all safety equipment as well as loss of power, those pumps are the last option for the heat removal.
Background	In a scenario with loss of heat sink there is the assumption that the connection between the pumps and loads is lost. All other systems operate normally and water is available from the Sava river. A water source for long-term operation is provided with the design provision of the demineralized water system or pre-treatment water system. Alternative water sources can be used for filling the condensate storage tanks (CST): demineralized water storage tanks, fire protection tank, condenser, circulating water tunnel, Sava river, and potable water from city of Krško. In case of inoperable CST and operable AFW pumps, water can be delivered to the suction of AFW pumps with portable fire protection pumps from the following water sources: demineralized water storage tanks, fire protection tank, condenser, circulating water tunnel, Sava river. In case AFW TDP is not available portable fire protection pumps can be used to supply water into both SGs. These pumps have enough capacity to remove the decay heat from the core and to maintain the level in both SGs to provide natural circulation on the primary side. Two high pressure mobile fire protection pumps will be purchased for the possibility to remove decay heat in early stage after reactor shutdown and depressurizing steam generators. Additionally, the connections are provided for the supply of cooling water for the oil coolers of charging and safety injection pumps. The installation of the connection on the non-safety related part of the piping and connection with portable/mobile fire protection pump can provide alternative cooling for the component cooling heat exchanger. The connection planned shall be the standard type A for fire protection equipment and it can be easily used with crew on-site. This alternative cooling has a limited cooling capacity, but it will have enough capacity to allow operation of the centrifugal charging pump, HPSI pump and even motor driven AFW pump or any other small heat load which will be necessary. The control room is cooled by the chilled water system, which is independent from the CCW and ESW.

	Alternative cooling can also be established with installation of 8'' tee on the existing 24'' ESW line to CCW heat exchangers to provide alternative connection for fire protection pump with higher capacity and connection size of 8''. The capacity of the already ordered pump »HFS HydroSub 450 floating unit«, is 720m^3/h, which can provide enough heat removal for one train of ECCS and also to remove decay heat from SFP. References: ENSREG, 2012. Slovenia. Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/403 SNSA (Slovenian Nuclear Safety Administration), 2011. Slovenian national report on nuclear stress tests, Final Report, December 2011, 190pp. http://www.ensreg.eu/node/355
To be discussed	The issues of interest include: ➢ What was the basis for selecting the pumps (size, other characterises)? ➢ What is the basis for establishing the connection points? ➢ The status of completeness (of acquisition of pumps and connection points). ➢ Status of the development of operating procedures. ➢ Testing of operating procedures and the whole installation.
Safety importance	Medium
Schedule	Medium term
Follow-up	Check list

<table>
<tr><td colspan="2">Slovenia</td></tr>
<tr><td colspan="2">Topic 2: Loss of safety systems</td></tr>
<tr><td>Issue No</td><td>SLO 2.7</td></tr>
<tr><td>Title</td><td>Quick connection points for mobile equipment and for power supply through the plant</td></tr>
<tr><td>Content</td><td>There are multiple modifications within this category. Those include installation of a standard fire water type A connection (usually with a flange and a valve, welded to an existing pipework) where fire hoses or similar could be quickly connected. In Krško case the following is planned (this is a non-inclusive list):
➢ 8'' tee on the existing 24'' ESW line to CCW heat exchangers.
➢ Connection for the mobile HX in the RHR circuit (?)
➢ A fire hose connection to (new) nozzles for SFP spray.
➢ Connection provisions to establish cooling water for the oil coolers of charging and safety injection pumps.
➢ Connections for various mobile power supply options.</td></tr>
<tr><td>Safety relevance</td><td>Those connections will allow the use of mobile equipment that is available or will be acquired. Mobile equipment might be considered a last line of defence in case of a large-scale destruction at the site.</td></tr>
<tr><td>Background</td><td>Immediately after the Fukushima accident the operator of the Krško NPP initiated the analysis to identify possible short-term actions that would raise the plant's preparedness for severe accidents. Some of the analyses serving similar purposes has been already undertaken, when implementing B.5.b requirements (post 9/11 requirements endorsed by the US NRC). The result of this analysis was that the safety benefits would be achieved by procuring additional portable equipment, e.g. AC diesel generators, pumps and compressors, implementation of quick connection points for this equipment. Also, amendments to the emergency operating procedures and severe management accident guidelines were made enabling the use of this new equipment to mitigate consequences in case of a severe accident. These modifications were to a large extent implemented by the end of June 2011 and were also considered in the stress test report submitted to the European Commission.

References:
ENSREG, 2012. Slovenia. Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/403
SNSA (Slovenian Nuclear Safety Administration), 2011. Slovenian national report on nuclear stress tests, Final Report, December 2011, 190pp. http://www.ensreg.eu/node/355</td></tr>
<tr><td>To be discussed</td><td>The issue of interest include:
➢ The design basis (in particular consideration of the access in case of large scale destruction), consideration of redundancy.
➢ The status of completion of installation.
➢ The status of procedures, for various sequences.
➢ The status of testing the connectability, operations.</td></tr>
</table>

Safety importance	High
Schedule	Medium term
Follow-up	Checklist

Slovenia	
Topic 2: Loss of safety systems	
Issue No	**SLO 2.8**
Title	Alternate cooling of SFP
Content	Installation of an alternate seismically qualified (2x SSE) cooling system for the SFP, to enable cooling in cases when the safety related cooling system for the SFP is unavailable. The details are not available. Installation of fixed piping around the SFP with spray nozzles and separate connections to be fed by any available sources at Krško site, including the fire pumps.
Safety relevance	The alternate cooling system for the SPF will be used when the main cooling system is not available, or when the CC HX is not available. In a case of non-accessibility of the SFP and failure of the SFP cooling system, evaporation will be main means of heat removal. After the drop of the water level for about 3 meters, the whole area will not be accessible due to radiation. Spray nozzles in operation will enable condensation of steam above the SFP, cooling of SF by direct contact and refilling of the SFP, all without a need to access the area. The connection of the spray nozzles will be outside the building allowing for feeding with any possible sources of water.
Background	In the Slovenian National Stress Test Report a solution/measure is identified for improving plant resistance to loss of ultimate heat sink concurrent with SBO: *New water line from Krško HPP could provide alternative way of cooling the component cooling heat exchanger by a passive means.* The Country Peer Review Report states that a new alternative UHS, totally separate from the Sava River, is under consideration, and this will be seismically-qualified, probably a cooling tower. The alternative UHS was, at the time of the peer review, at the study phase. While it is obvious, in particular in the view of Fukushima experience, that the alternate SFP cooling as well as any installation/connection that would allow for the initiation of the cooling and resupply of water to the SFP from a remote location is essential, it is not known which solution Krško is considering to cope with this vulnerability. References: ENSREG, 2012. Slovenia. Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/403 SNSA (Slovenian Nuclear Safety Administration), 2011. Slovenian national report on nuclear stress tests, Final Report, December 2011, 190pp. http://www.ensreg.eu/node/355
To be discussed	The issues of interest, to be presented and discussed during the workshop, include: ➢ The design for both the dedicated (if so decided) SFP cooling systems and the installation/nozzles to enable external connection. ➢ The resistance of the installation to external hazards, selection of connection points, access in a case of debris at the site. ➢ Limits on the system operability; power & water supply concept, implementation; connection with other systems, separation.

	➢ Schedule for design, implementation and licencing.
Safety importance	High
Schedule	Long term
Follow-up	Dedicated workshop together with SLO 2.4, 2.5 and 2.9

Slovenia	
Topic 2: Loss of safety systems	
Issue No	**SLO 2.9**
Title	Mobile heat exchanger
Content	A skid mounted (mobile) heat exchanger with appropriate pump for alternative cooling of the RHR or the SFP is planned. The technical solution is not available, but it might be either air cooled or water cooled, in which case the fire pump connection will be available to feed the secondary side of the HX. The primary side would be connected to either the SFP or RHR pipework, likely with fire hoses. In the Stress test report it appears as a "skid mounted HX with pump", while in the Extraordinary CNS report it appears as the "mobile heat exchanger". What is actually planned needs to be verified in discussions.
Safety relevance	This is like an ultimate reserve alternative for the heat removal from the reactor and SFP. As the heat removal for the reactor might be accomplished in several ways, including primary F&B, RHR and the secondary side, it is likely to be more important for the SFP, if the heat removal by steaming is not acceptable.
Background	If loss of all AC power occurs, SFP cooling pumps would be lost and the cooling flow to the SFP heat exchangers would be lost. The temperature of water in SFP would start to increase. At that point heat removal from the SFP is established by water boiling in the SFP. For maintaining the constant water level in the SFP it is required to deliver adequate water flow. In the case of the maximal possible decay heat from the fuel in the SFP (8.5 MW), the boiling time until the minimum allowable level is reached is 4 hours and 28 minutes. 14.1m^3/h of makeup water flow to the SFP is required to maintain constant water level after start of boiling. If water is not delivered into the SFP, then the USAR limit 3.05m above of the top of fuel elements would be reached after 47 hours after event initiation. Procedures instruct the operators to monitor the SFP level and temperature and to initiate the makeup to the SFP. Alternative means for establishing spent fuel pool makeup: – Pumping water from water pre-treatment tanks with portable fire pump to the system for purification of SFP water surface. – Providing water from fire protection hydrant network to the system for purification of SFP water surface. This method requires pressurized fire protection hydrant network by installed diesel fire pump. – Pumping water from pool near water pre-treatment building with portable fire pump to the system for purification of SFP water surface. – Pumping water from circulating water intake pool with submersible fire pump and fire track to the system for purification of SFP water surface. – Pumping water directly to SFP from fire protection system. If water in the SFP is decreasing even if makeup to the SFP is established, then operators are instructed to establish water spray over the spent fuel before the water drops below 3.05m above the spent fuel elements. Water spray with portable fire protection nozzles ensures adequate cooling of spent fuel elements. The order of the priority of water sources to be used is: fire protection hydrant network, water pre-treatment tanks, intake pool near water

	pre-treatment building, circulating water intake and circulating water outlet pool. No cliff edge effects have been identified for a period of more than seven days because usage of alternative equipment assures spent fuel heat removal. All alternative equipment can be connected to the various systems through installed connection points by equipment operators from shift crew and firemen from fire team on-site in less than one hour. Regular training and drills for shift crews and fire team are conducted periodically. References: ENSREG, 2012. Slovenia. Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/403 SNSA (Slovenian Nuclear Safety Administration), 2011. Slovenian national report on nuclear stress tests, Final Report, December 2011, 190pp. http://www.ensreg.eu/node/355
To be discussed	While the needs and the idea are known, the concept and the design solution are not available. During the workshop it is expected that the Slovenian side will present the design solution and issues related to implementation, in particular including: ➢ The possibilities to connect the mobile HX, locations and means. ➢ The operability of the mobile HX, primary and secondary side cooling media and the circulation. ➢ Power supply to pumps/fans; I&C and controls (any valves, dumpers). ➢ Storage during normal operation. Bringing the HX into function during emergencies. ➢ Operation autonomy, supports needed.
Safety importance	Medium
Schedule	Long term
Follow-up	Dedicated workshop together with SLO 2.4, 2.5 and 2.8

3.3 Topic 3: Severe Accident Management

Slovenia	
Topic 3: Severe Accident Management	
Issue No	**SLO 3.1**
Title	Filtered containment venting
Content	Implementation of a filtered venting system for controlled depressurization of the containment in case of an accident is planned at Krško, with high priority. So far, venting can only be performed via unfiltered pathways. The venting system is to have over 99.9 % filtering efficiency (excluding noble gases) and is to be completed by the end of 2013.
Safety relevance	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. Unfiltered venting leads to significant fission product releases and therefore can only be regarded as the last option to avoid overpressure failure. The releases in case of filtered venting are considerably lower (apart from noble gases)
Background	According to the **National Stresstest Report**, containment venting at Krsko can be performed as a last resort if other methods of pressure control (fan coolers, spray system) fail, via unfiltered pathways not designed for venting. (A pathway via SFP exhaust ventilation with filtering capability is also mentioned briefly, but not discussed further.) It is emphasized that venting does not serve the purpose of completely de-pressurizing the containment, and that the release can be terminated as soon as the pressure falls below dangerous levels (section 6.2.2.2). In the **Peer Review Country Report**, the lack of filtered containment venting is listed among the weak points (section 4.2.2.2). It is also mentioned that introduction of filtered venting is planned in the course of an action plan which is to be implemented by the end of 2016 (section 4.2.4.1). According to the **Slovenian Report to the 2nd Extraordinary CNS Meeting**, the measure to implement a *[filtered venting system capable of depressurizing containment and filtering over 99.9% of volatile fission products and particulates (not including noble gasses)* is to be completed by the end of 2013 (section 1.1.2). Thus, this Issue appears to have been assigned a high priority, since there are only two measures with deadline 2013, all other measure have a later deadline. In the **National Action Plan**, this information is repeated (table 3 – Safety Upgrade Program (SUP). References: ENSREG, 2012. Slovenia. Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/403 SNSA (Slovenian Nuclear Safety Administration), 2011. Slovenian national

	report on nuclear stress tests, Final Report, December 2011, 190pp. http://www.ensreg.eu/node/355 SNSA (Slovenian Nuclear Safety Administration), 2012. Slovenian Report for the 2nd Extraordinary CNS Meeting of the Parties of the Convention on Nuclear Safety, April 2012, 58 pp. http://www.ursjv.gov.si/fileadmin/ujv.gov.si/pageuploads/en/Porocila/NationalReports/Slovenia.pdf SNSA (Slovenian Nuclear Safety Administration), 2012. Slovenian Post-Fukushima National Action Plan, December 2012. http://www.ensreg.eu/node/684
To be discussed	Questions which should be addressed in a presentation include: ➢ Analyses performed as basis for the design of the filtered venting system (scope, methods and results). ➢ Description of design and operation of the filtered venting system; for which scenarios can it be used, what is the efficiency? ➢ Characteristics of the filtered venting system in case of long-term operation. ➢ 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? Since this measure is to be implemented by the end of 2013, it would be appropriate to discuss it at an early date.
Safety importance	High
Expected schedule	Short term
Follow-up	Dedicated presentation

Slovenia	
Topic 3: Severe Accident Management	
Issue No	**SLO 3.2**
Title	Hydrogen management by passive autocatalytic recombiners, and presence of hydrogen in unexpected places
Content	Hydrogen management during a severe accident is to be improved at Krško NPP with high priority. At present, a combination of measures is to be used, which depend on electricity supply. Now, it is planned to install a large number of passive autocatalytic recombiners (PARs), as they are used or being installed in most PWRs in Europe, in different compartments of the containment. Furthermore, an analysis will be performed regarding the presence of hydrogen in unexpected places, e.g. the SFP building. The measure is to be implemented by the end of 2013.
Safety relevance	Hydrogen deflagration or detonation can lead to containment failure, and to large releases. Hydrogen in unexpected places can lead to explosions, damaging buildings and safety-relevant components and thus aggravating the consequences of an accident.
Background	According to the **National Stresstest Report** (section 6.2.2.1), hydrogen management in the containment is to be performed by two electric recombiners and two hydrogen purge systems for DBAs. During severe accidents, a combination of measures is to be used (isolating potential ignition sources and adding steam to the containment atmosphere; as last resort, venting through the hydrogen purge system). There are no passive autocatalytic recombiners (PARs). The possibility of the presence of hydrogen in other places (annulus, spent fuel pool building) is briefly addressed. There is no hydrogen monitoring in the annulus area. Regarding the SFP, the strategy is to prevent overheating of the fuel elements by adding water to the pool. In the **Peer Review Country Report**, this situation is noted as a weak point, and it is mentioned that it is planned to back-fit PARs (sections 4.2.2.2, 4.2.4.1). This would provide passive and more straightforward means in case of severe accidents. It is planned in the course of an action plan which is to be implemented by the end of 2016. According to the **Slovenian Report to the 2nd Extraordinary CNS Meeting**, the replacement of the electric recombiners by PARs is to be completed 2013. Thus, this Issue appears to have been assigned a high priority, since there are only two measures with deadline 2013, all other measure have a later deadline. In the **National Action Plan**, some more details are provided. It is stated that, as part of the Safety Upgrade Program (SUP) replacement of electric DBA recombiners with passive BDBA auto-catalytic recombiners in the containment is planned. The two electric DBA recombiners will be removed and a significantly larger number of BDBA PARs will be installed into different containment compartments for managing severe accidents hydrogen. The

	deadline for completion (2013) is confirmed (NAcP, p. 8) According to the NAcP, the issue “presence of hydrogen in unexpected places” (ENSREG recommendation 3.3.10) will also be covered with the analysis that will represent the basis for the installation of the PARs in 2013 (NAcP, p. A-13). It is not clear what the scope of the analysis regarding presence of hydrogen in unexpected places will be, and which schedule can be expected for measures in this context, should any be required. References: ENSREG, 2012. Slovenia. Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/403 SNSA (Slovenian Nuclear Safety Administration), 2011. Slovenian national report on nuclear stress tests, Final Report, December 2011, 190pp. http://www.ensreg.eu/node/355 SNSA (Slovenian Nuclear Safety Administration), 2012. Slovenian Report for the 2nd Extraordinary CNS Meeting of the Parties of the Convention on Nuclear Safety, April 2012, 58 pp. http://www.ursjv.gov.si/fileadmin/ujv.gov.si/pageuploads/en/Porocila/NationalReports/Slovenia.pdf SNSA (Slovenian Nuclear Safety Administration), 2012. Slovenian Post-Fukushima National Action Plan, December 2012. http://www.ensreg.eu/node/684
To be discussed	Questions which should be addressed in a presentation include: ➢ Analyses performed as basis for PAR selection, sizing and installation (accident scenarios considered, methods and results). ➢ Analyses regarding presence of hydrogen in unexpected places (accident scenarios considered, methods and results). Consequences of this analysis. Are there further measures planned? If so, what is the schedule of their implementation? ➢ Description of the hydrogen recombination system in the containment (number and location of PARs, description of PARs…). ➢ 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? Since this measure is to be implemented by the end of 2013, it would be appropriate to discuss it at an early date.
Safety importance	High
Expected schedule	Short term
Follow-up	Dedicated presentation

Slovenia	
Topic 3: Severe Accident Management	
Issue No	**SLO 3.3**
Title	Access to site by emergency staff
Content	In case of extensive destruction of infrastructure, the access to the Krško plant for emergency staff could be impeded. In particular, the bridges over the Sava River could be damaged. In spite of the fact that there are other possibilities to cross the river, this was identified as a “possible area for improvement” in the Stresstest.
Safety relevance	If an extensive external event occurs, access to the site for a sufficient number of qualified personnel is vital. This is of particular importance if an accident situation of longer duration develops. In this case, it must be possible for personnel replacements to reach the site, as well as for supplies.
Background	In the Slovenian **National Stresstest Report**, the question of access to the plant in case of extensive destruction of infrastructure is discussed in section 6.1.2.1. It is pointed out that most plant workers live in the vicinity of the plant. Therefore, it is estimated that a sufficient number of workers could reach the site in any credible circumstances. However, in case of extensive external events, *some aggravating circumstances could be expected regarding the accessibility of the Krško site for plant emergency staff. It was estimated that the bridges over the Sava River present probably the weakest points regarding the access to the facility in case of a strong earthquake*. It is also pointed out that there are many possibilities to cross the river from different directions, among them the river dam structure at the site. In the **Peer Review Country Report**, this point was addressed in section 4.2.2.2. The statement from the National Report concerning the bridges over the Sava river is repeated and the issue is listed as a “possible area for improvement”. This issue is not addressed in the Slovenian Report to the 2nd Extraordinary CNS Meeting and the National Action Plan. References: ENSREG, 2012. Slovenia. Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/403 SNSA (Slovenian Nuclear Safety Administration), 2011. Slovenian national report on nuclear stress tests, Final Report, December 2011, 190pp. http://www.ensreg.eu/node/355 SNSA (Slovenian Nuclear Safety Administration), 2012. Slovenian Report for the 2nd Extraordinary CNS Meeting of the Parties of the Convention on Nuclear Safety, April 2012, 58 pp. http://www.ursjv.gov.si/fileadmin/ujv.gov.si/pageuploads/en/Porocila/NationalReports/Slovenia.pdf SNSA (Slovenian Nuclear Safety Administration), 2012. Slovenian Post-Fukushima National Action Plan, December 2012.

	http://www.ensreg.eu/node/684
To be discussed	Questions which should be addressed in a presentation are: ➢ Are there any activities to follow up the questions of access to the site in case of extensive external events? If so, which activities have been decided, and what is the schedule for implementation? if no measures have been decided, why not? ➢ Which measures would be conceivable to improve the access situation in case of extensive external events? It seems appropriate to enquire for further information soon. The follow-up will depend on whether activities are taken at all, and if so, how extensive they are.
Safety importance	High
Expected schedule	Medium term
Follow-up	Dedicated presentation

Slovenia	
Topic 3: Severe Accident Management	
Issue No	**SLO 3.4**
Title	Emergency control room
Content	An emergency control room (ECR) is to be implemented at Krško by the end of 2016. At present, the only backup for the main control room are three shutdown panels. The ECR is to be qualified for a high seismic load and will have provisions to ensure long term habitability for the staff.
Safety relevance	Functioning of the control rooms is crucial in case of a severe accident. Conditions may develop which render the main control room inhabitable or inaccessible. So far, only several shut-down panels exist as backup. The installation of a robust ECR (seismic qualification well beyond the PGA of 0.56 g – 2xSSE would correspond to 1.12 g) for all required functions as a backup increases the chances for successful accident mitigation.
Background	According to the **National Stresstest Report** (section 6.1.2.2), there is no emergency control room as backup of the main control room. In case the MCR has to be evacuated, three shutdown panels are available in the plant with control and monitoring capability to achieve cold shutdown. The **Peer Review Country Report** notes that installation of a seismically qualified emergency control room (ECR) is planned in the course of the action plan which is to be implemented by the end of 2016 (section 4.2.4.1). The reviewers regard this as in important measure (section 4.3). In the **National Action Plan**, it is stated that, as part of the Safety Upgrade Program (SUP), relocation and expansion of existing remote shutdown panels into a new ECR in the separate bunkered (2× safe shutdown earthquake (SSE) and probable maximum flood protected) building is planned, with all I&C needed for safe shutdown of the plant and maintaining the safe shutdown conditions. The measure is to be completed 2016. This ECR will enable long term habitability for control room staff even during severe accidents (air filtering, radiation protection). For the same conditions, also a new facility for supporting staff will be designed and built (2016) (NAcP p. 9). Similar information on this Issue is contained in the **Slovenian Report to the 2nd Extraordinary CNS Meeting.** References: ENSREG, 2012. Slovenia. Peer review country report. Stress tests performed on European nuclear power plants. http://www.ensreg.eu/node/403 SNSA (Slovenian Nuclear Safety Administration), 2011. Slovenian national report on nuclear stress tests, Final Report, December 2011, 190pp. http://www.ensreg.eu/node/355 SNSA (Slovenian Nuclear Safety Administration), 2012. Slovenian Report for the 2nd Extraordinary CNS Meeting of the Parties of the Convention on

	Nuclear Safety, April 2012, 58 pp. http://www.ursjv.gov.si/fileadmin/ujv.gov.si/pageuploads/en/Porocila/NationalReports/Slovenia.pdf SNSA (Slovenian Nuclear Safety Administration), 2012. Slovenian Post-Fukushima National Action Plan, December 2012. http://www.ensreg.eu/node/684
To be discussed	Questions which should be addressed in a presentation are: ➢ Design basis for the new ECR. ➢ Description of the new ECR (loads from external events the ECR is designed against; capabilities for monitoring and control; measures for protecting the staff). ➢ 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? This measure could be discussed before its final completion, but at a time when planning has been completed and implementation is on-going.
Safety importance	High
Expected schedule	Medium term
Follow-up	Dedicated presentation

Slovenia	
Topic 3: Severe Accident Management	
Issue No	**SLO 3.5**
Title	Full scope PSA level 2
Content	There are living PSAs level 1 and 2 for Krško NPP. The level 2 PSA only includes full power modes. A full scope level 2 PSA, including low power and shutdown states, is to be implemented. At present, however, it is delayed to wait for new developments of US standards. The deadline is not clear.
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. Nevertheless, a PSA is a very useful tool to identify vulnerabilities as well as to quantify releases, although with considerable uncertainties. Low power and shutdown states can contribute significantly to overall plant risk; hence, their inclusion in a PSA is of importance for safety.
Background	The **National Stresstest Report** states that there is a level 2 PSA for Krško NPP for full power modes, including internal and external initiators. The level 1 PSA also includes low power and shutdown states. These PSAs are denoted as living PSAs. (section 1.4) According to the **National Action Plan**, a full scope PSA (including Level 2) for low power and shutdown events shall be implemented by the end of 2015 (Table A2 No. 144, p. A-14). At the **Bilateral Meeting** in October 2012, the Slovenian side stated that the low power and shutdown PSA has been postponed. Licensee and authority are waiting for new US standards for low power and shutdown operation PSA, which are in development but significantly delayed. No new deadline was provided for the completion of the level 2 low power and shutdown PSA. References: SNSA (Slovenian Nuclear Safety Administration), 2011. Slovenian national report on nuclear stress tests, Final Report, December 2011, 190pp. http://www.ensreg.eu/node/355 SNSA (Slovenian Nuclear Safety Administration), 2012. Slovenian Report for the 2nd Extraordinary CNS Meeting of the Parties of the Convention on Nuclear Safety, April 2012, 58 pp. http://www.ursjv.gov.si/fileadmin/ujv.gov.si/pageuploads/en/Porocila/NationalReports/Slovenia.pdf SNSA (Slovenian Nuclear Safety Administration), 2012. Slovenian Post-Fukushima National Action Plan, December 2012. http://www.ensreg.eu/node/684

To be discussed	Questions which should be addressed in a presentation include: ➢ Description of the level 2 PSA for low power and shutdown states (scope, methods, results). How will this study be integrated with the full power PSA? ➢ Which post-Fukushima improvements have already been taken into account in the level 2 living PSA for full power modes? Which improvements will have to be included in the next update of the PSA? ➢ What can be said about the effect of post-Fukushima improvements (already implemented and planned according to the SUP) on LERF and LRF? ➢ What are the actual schedules for the level 2 PSA for low power and shutdown states and for the further development of the full power level 2 PSA?
Safety importance	Medium
Expected schedule	Medium term
Follow-up	Dedicated presentation