Post Fukushima

National Action Plan (NAcP)

on
Strengthening Nuclear Safety of Nuclear Facilities
in the Czech Republic

State Office for Nuclear Safety
8.1.2018

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1. Introduction

Post Fukushima National Action Plan (NAcP) on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic follows the National Report on „Stress Tests“ of Dukovany NPP and Temelín NPP, Czech Republic [1], prepared under the initiative of the European Commission in response to the Fukushima nuclear power plant accident.

In accordance with the specifications elaborated by a group of European Nuclear Regulators ENSREG the national stress tests report analysed in detail the safety aspects of Dukovany and Temelin NPPs in terms of extreme external conditions, particularly their robustness against beyond design basis earthquakes, floods and extreme weather conditions leading to loss of ultimate heat sink, complete loss of electrical power (black out) or a combination thereof. The aim of the stress tests was to assess the resistance of existing nuclear power plants to these extreme loads, to assess time reserves to cliff edge moments of irreversible damage of the reactor core and to propose measures to strengthen their overall robustness in similar extreme situations.

National stress tests report has resulted in the conclusion that the design basis, which was used in the design of both nuclear power plants is in accordance with the valid nuclear legislation of the Czech Republic and that they both have sufficient reserves to the analyzed very unlikely extreme events. Detailed analyses of the behaviour of nuclear power plants in these extreme conditions allowed to propose a number of specific technical and administrative measures to further enhance their robustness and delaying the onset of irreversible damage of the nuclear fuel and barriers preventing release of fission products into the plant and then into the environment.

National Report of the Czech Republic along with national reports of other countries were subject to a detailed assessment by an independent group of international experts, initially in topically oriented peer review organized by the European Commission and the ENSREG in February 2012 in Luxembourg. The results of this topical peer review were summarized in two forms: first in a summary report generalizing conclusions and recommendations based on all national reports [2], secondly, in national evaluation peer review reports, which were a basis for subsequent evaluation missions (so-called "country visits") associated with visit of a selected nuclear power plant. In the case of the Czech Republic it was the Dukovany NPP. Conclusions of this evaluation were summarized in the final "Peer Review Country Report” [3], containing in addition to the general summary evaluation a list of recommendations for further improvement of nuclear safety in the Czech Republic, both of general nature and specific for Dukovany and Temelín NPPs. This assessment by independent international experts confirmed the general conclusions of the National Report on the compliance of design bases of the Czech nuclear power plants with applicable national laws and international practices. Final review of stress tests of the Czech NPPs by ENSREG group ended with a visit to the Temelín NPP in September 2012, the conclusions of which were summarized in the report [4].

National stress tests report of the Czech nuclear power plants was in a condensed form [5] also presented to the Second Extraordinary Meeting of the Parties to the Convention on Nuclear Safety, which took place on 27 - 31 August 2012 at the International Atomic Energy Agency (IAEA). Conclusions of this meeting, summarized in a document [6] became, like the conclusions of the evaluation of stress tests carried out within the group ENSREG, a source of ideas for further increasing the level of nuclear safety of Contracting Parties to the Convention, including the Czech Republic.

Recommendations from the review processes within the ENSREG Group and the Extraordinary meeting of the Contracting Parties to the Convention on Nuclear Safety, along with opportunities to enhance robustness of Dukovany and Temelín NPPs identified in the National Stress Tests Report form a set of measures, which represent the basis of the present National Action Plan (NAcP) on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic

National Action Plan on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic contains a compilation of all the major conclusions and recommendations contained in the National Stress Tests Report on nuclear power plants of the Czech Republic [1], reports from the peer review process by the ENSREG group [2,3,4], including the Final Summary Report of the 2nd Extraordinary Meeting of the Contracting Parties to the Convention on Nuclear safety [6]. The National Action Plan is structured, in accordance with the structure suggested by ENSREG [7], into four parts. Part I is devoted to the issues of external hazards (earthquakes, floods, extreme weather conditions), the loss of ultimate heat sink and complete loss of electrical power, eventually their combination. Part II deals with the national organization, the organization of emergency preparedness and emergency response, and international cooperation, as were evaluated at an extraordinary meeting of the Convention on Nuclear Safety. Part III is devoted to the crosscutting issues. The focus of the Action Plan - Part IV - contains the list of measures aimed in implementing all the recommendations contained in parts I - III. The set of these measures is the sum of corrective actions identified in the Periodic safety review of Dukovany NPP and Temelín NPP after 20, respectively 10 years of operation, safety findings by the IAEA missions, findings identified within the project LTO EDU and last but not least, the findings identified in the stress tests after the Fukushima nuclear power plant disaster.

Proposed measures relating to Dukovany NPP and Temelín NPP will be implemented by the licensee ČEZ, a. s. Measures of general nature, such as the amendment of the nuclear legislation, off-site emergency preparedness, international cooperation, etc. will be implemented by the state administration, especially SÚJB and other ministries.

National Action Plan on Strengthening Nuclear Safety of Nuclear Facilities in the Czech Republic is a living document which will be regularly reviewed and based on new knowledge continuously updated.

1.1 NAcP revision history

1.1.1 Revision 0 of NAcP

Revision 0 of the NAcP was prepared on the basis of the ENSREG specifications in December 2012.

1.1.2 Revision 1 of NAcP

Revision 1 of the NAcP was prepared to comply with the outcome of the ENSREG workshop to NAcP in April 2013 in Brussels and the results of the SÚJB assessments from the date of issue of NAcP in December 2012.

The main changes included in the revision 1 of NAcP:
- links between recommendations and actions have been refined,
- several actions have been added in consequence of SÚJB decision,
- status of the actions has been updated.

1.1.3 Revision 2 of NAcP

Revision 2 of the NAcP has been prepared on the basis of the ENSREG documents (see references [8], [9] and [10]) in order to supplement the information requested for the ENSREG National Action Plan Workshop held in April 2015.

a) Response to the findings contained in the report of the first ENSREG NAcP workshop held in Brussels in 2013 (reference [10]).

   Based on the evaluation of reference [10], we concluded that the general findings set out in Part 3 of reference [10], which are practicable in the Czech Republic, are already reflected in previous revisions of the NAcP. Based on the findings set out in Part 3 of reference [10] Revision 1 of the NAcP has been developed, in which links between parts I - III of the NAcP summarizing the results of stress tests and Part IV of the NAcP containing the relevant action were clearly shown.

b) The process of implementation of the action included in NAcP

   Status of implementation of individual actions has been updated in the Revision 2 of NAcP - see Part IV of the NAcP. Actions are being implemented as scheduled.

c) Main changes in the NAcP since the ENSREG workshop held in April 2013

   - Additional measures:
     Actions 77-84, which emerged from a detailed analysis of ENSREG documents made in the period from May to September 2013, have been added to the NAcP Revision 1. Thereafter were found no reasons to supplement other additional actions.
   - Measures removed or modified:
     No actions were removed. Based on the results of the Action 49 the completion time of the Action 50 was set.
     The results of analyzes carried out under the Action 49 have shown that an effective strategy for stabilizing the corium and maintaining long-term containment integrity is spilling corium leaked from the reactor pressure vessel and its flooding by coolant, thus ex-vessel cooling of the corium (ExVC). Under Action 49 the schedule of implementation steps of ExVC was developed. The schedule was discussed with SÚJB.
     Under the Action 49 it was analytically demonstrated that long-term control of pressure in the containment is possible by way of heat removal (using design, diverse or alternative systems). As part of the Action 50 the strategy for containment heat removal will be developed and then implemented into SAMGs.
     Within the Action 50 specific technical solutions will be designed and the method of implementation of measures for ExVC will be elaborated. This will also include establishing a strategy for containment flooding and heat removal from the containment using design, diverse and alternative measures. Further measures to spill corium, to protect concrete of the floor and walls in the spilling area (refractory lining) and to define the melt pool will be implemented. The new strategies will be implemented into SAMG.

Since the IVR strategy is preferable in terms of severe accident management the study of effectiveness and applicability of the IVR strategy will continue in parallel.

- Changes in the schedule

  Although the schedule was and still is ambitious (its fulfillment is stated in reference [10] as one of the challenges), it has not been modified and it is met.

d) Technical basis leading to the main changes identified in the NAcP

The reason for the changes in Revision 1 of the NAcP and addition of the Actions 77-84 was a detailed analysis of ENSREG documents conducted in the period from May to September 2013, which resulted in the finding that some of the inputs were not given an adequate action in Revision 0 of the NAcP.

e) Relevant outcomes of studies and analyzes identified in the NAcP, and completed since the 2013 ENSREG workshop

Analysis of the ExVC strategy:

Results of the experimental programs OECD/NEA MCCI and MCCI2 were used for the analysis of ExVC. The experimental verification, especially the test CCI-7 (which is relevant for ETE in terms of concrete composition), showed that flooding the melt from above cannot stop concrete ablation in case of siliceous concrete. The development of the strategy was focused on prevention of corium-concrete interaction.

An analytical verification has shown that the refractory lining of the spilling area is able to delay an attack on concrete for a long enough. The verification analysis with a refractory lining have demonstrated that there is no attack on concrete in case of immediate flooding and additional analysis with delayed flooding (after 1 hour) have proved that there is no penetration of corium through the refractory lining. The proposed strategy is effective in terms of maintaining containment integrity. Refractory material choice and its experimental verification and design of lining remain outstanding issues.

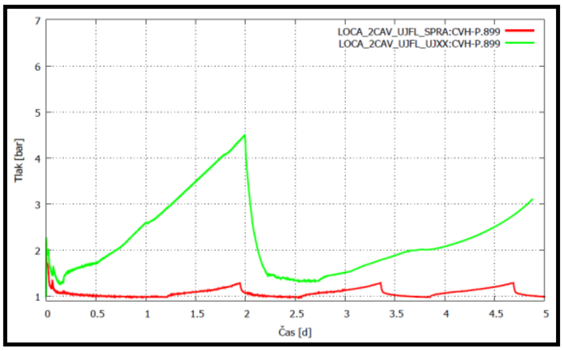
Analysis of IVR strategy:

Safe heat removal (i.e. not exceeding the critical heat flux (CHF)) from the surface of the reactor pressure vessel cannot be secured with the original design of the reactor cavity. Calculations have shown that under specific conditions sufficient heat removal from the reactor pressure vessel can be ensured to maintain its integrity. To do so, it is necessary to design a suitable configuration of the reactor cavity (size of deflector, removing steam from the cavity and coolant injection).

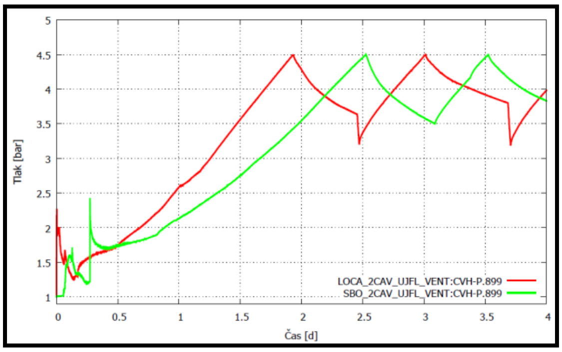
For application of IVR strategy basic analytical research must be completed, large-scale experiments must be conducted to quantify the margin to boiling crisis and implementation of complex design modifications on the surface of the reactor pressure vessel, in the reactor cavity and inside the containment must be developed and designed. Because the IVR could be due to the current state of knowledge implemented in the long term (10+ years), the possibility of cooling the melt outside the reactor pressure vessel (ExVC) was also studied.

Risk of containment overpressurization:

Analysis has shown that pressure in containment increases faster after corium flooding because all the heat is removed into the water. Heat removal from the containment atmosphere by means of spraying (providing heat removal) is sufficient to maintain the safe pressure in the containment. The necessity of installing a filtered venting to ensure long-term integrity of the containment due to the release of non-condensable gases generated during ExVC has not been confirmed.



spraying



venting

f) Good practices and challenges identified during implementation of NAcP

The ambitious schedule of actions implementation, which is met, is both a challenge and a good practice.

SÚJB is monitoring status of individual actions in detail. Results of analyzes are regularly discussed between the regulator and the operator and implementation of actions at both NPPs is verified within inspections carried out by SONS inspectors. This procedure, as well as the fulfillment of the ambitious schedule, is both a challenge and a good practice. There are no major uncertainties in the results of analyzes carried out either in the state of implementation of individual actions. Nevertheless, it is necessary to put more effort into implementation progress of actions and the quality of their outputs both on the part SÚJB, and on the part of the operator.

1.1.4 Revision 3 of NAcP

Revision 3 of the NAcP has been prepared on the basis of the ENSREG requirement with the goal to update information on status of Actions as it was on 31.12.2017 – par. IV NAcP – 6. Implementation of actions – summary:

a) No actions have been cancelled or modified.
b) Status of actions scheduled for implementation after NAcP revision 2 issuance has been updated. All actions have been finished with the exception of the following three actions:
   - Action No. 69 - PSA level 2 update is finished for EDU NPP, PSA level 2 update for ETE NPP shutdown modes and SFPs will be finished in 2018.
   - Action No. 77 - extensions of SAMGs by incorporating long-term activities in accordance with the findings of EPRI. Guidelines for the use of alternative technical FLEX means have been issued in the framework of Action No. 53. FLEX guidelines have been incorporated in updated EDU and ETE SAMG. Implementation of EPRI's findings into SAMG was postponed due to the delay of EPRI project and will be completed in 2018.
   - Updated information on the status of Action No. 50:

Based on the results of Action 49 and other analytical activities carried out, the target date for the implementation of the measure under point 50 was confirmed. Additional technical measures under point 50 will be carried in a reasonably achievable range with respect to real safety benefits. The strategy is the continuous strengthening of all available defence in depth lines.

2. European level recommendations

No.	Recommendations	Activity Action No.
	Recommendations from ENSREG "Compilation of recommendations and suggestions"	
1	The peer review Board recommends that WENRA, involving the best available expertise from Europe, develop guidance on natural hazards assessments, including earthquake, flooding and extreme weather conditions, as well as corresponding guidance on the assessment of margins beyond the design basis and cliff-edge effects.	**12**
2	The peer review Board recommends that ENSREG underline the importance of periodic safety review. In particular, ENSREG should highlight the necessity to re-evaluate natural hazards and relevant plant provisions as often as appropriate but at least every 10 years. External hazards and their influence on the licensing basis should be reassessed periodically using state-of-the-art data and methods. PSR was identified as one good tool.	**None (PSR is in the current practice)**
3	Urgent implementation of the recognised measures to protect containment integrity is a finding of the peer review that national regulators should consider.	**49, 46 – 50**
4	Necessary implementation of measures allowing prevention of accidents and limitation of their consequences in case of extreme natural hazards is a finding of the peer review that national regulators should consider.	**Many (see other parts of the NAcP)**
5	Deterministic methods should form the basis for hazard assessment. Probabilistic methods, including probabilistic safety assessment (PSA), are useful to supplement the deterministic methods.	**Implemented in the current practice (including the PSA use)**

PART I

3. Other topics

3.1 Topic I – Natural hazards

Earthquake

In the Czech Republic, there are no tectonic structures which could result in severe earthquakes. There is 95% probability that the Dukovany NPP site cannot be hit by an earthquake severer than 6° MSIS-64 (PGA hor = 0.06 g). The real SSC robustness is higher, so there is a safety margin for the remaining 5 % uncertainty.

Nevertheless, as early as 1995, a decision was made to perform seismic upgrading of the significant safety equipment and civil structures in the Dukovany NPP area to the value of the peak ground acceleration PGA = 0.1 g (the maximum design basis earthquake, MDE/DBE-2/SSE). This project is still underway. Currently, more than 90% (including all technology) of the significant safety equipment has qualification documentation which complies with requirements and proves seismic resistance, and, as for other equipment, (electro part and I&C systems) implementation of modifications is drawing to an end. Potential hypothetical consequences of an earthquake are limited to loss of seismically non-resistant SSC which might take part in fulfilment of supporting safety functions. It concerns, above all, possible insufficient mobile equipment capacity, people and loss of communication facilities. As a consequence of the damaged infrastructure in the surroundings of the nuclear power plant, it would be the loss of operability of the technical communication facilities between control centres and persons taking actions, including communication with external control centres and the state administration bodies, which would make actions complicated. The objective of the proposed measures is further strengthening of the in-depth defence level during an earthquake. (National report, page 78)

As clearly shown in the assessment, the site of the NPP Temelín was chosen exceptionally well from seismic point of view. The site can be characterized as highly stable in relation to external natural events, including seismicity. Moreover, the robustness of the VVER1000 project and diversity of the seismically resilient SSC ensure a sufficient resilience and safety margin in case of design and beyond design seismic events.
The potential adverse effects of earthquakes are, therefore, limited only to seismically nonresilient SSC, which may be contributing to the fulfilment of auxiliary safety functions. This is the case of, for example, a long-term power supply after losing the external power supply (3 days and more) using just emergency sources, which require external resupplying with diesel fuel for the DG.
Activities after a seismic event could also be complicated by a loss of the means of communication between the control centres and responding persons including the communication with external control centres and state administration due to damaged infrastructure around the NPP. The aim of the proposed measures is further strengthening of defence-in-depth protection in case of earthquakes. (National report, page 216)

At the end of 2017, all actions related to the above mentioned issues were completed.

Flooding

The basic design basis provisions to prevent occurrence of floods due to precipitation, in addition to the sitting of the power station, is the sufficiently dimensioned storm-water disposal system, the above-ground height of entrances, accesses and gates with respect to the surrounding ground space and weathering of the adjacent communications and other outdoor areas adjacent to buildings essential from the point of view of nuclear safety. All the civil structures located in the Dukovany NPP premises are safely protected by means of the altitude level of the premises.
(National report, page 83)

The site of the Temelín NPP has never been, and is not now, threatened by floods from watercourses. The main objects of the Temelín NPP containing systems relevant for nuclear safety are located 507.30 m above sea level. This is 135 m above the level of the Hněvkovice water reservoir on the Vltava River. A safety evaluation with respect to the potential breaking of dams on water reservoirs in the upper part of the Vltava River (Lipno I on the Vltava, Římov on the Malša) was carried out for the Temelín NPP. In case the Lipno I reservoir is damaged, water approximately equalling a 10,000-year flood will flow through the profile of Hněvkovice. In case of a 10,000-year flood, the level reached in the profile of Hněvkovice will lead to flooding of most of the pumping station supplying raw water for the Temelín NPP, which will disable the standard raw water supply for the Temelín NPP, and both units will have to be shutdown. However, the site contains a sufficient reserve of water to cool down the units to a cold state. During the biggest floods on the Vltava River in 2002, the profile of Hněvkovice recorded a level corresponding to the maximum level considered for this water reservoir. Water was passing through the dam in a standard way and no significant damage was found on the pumping station for the Temelín NPP or on the dam. Buildings relevant for safety cannot be flooded from the gravity sewer system even in case of extreme precipitation. The Temelín NPP is built as a cascade, with buildings relevant for nuclear safety located in the highest areas and the terrain sloping towards the edges of the location, which also allows for natural gravity drainage if the rain sewer fails. The building objects in the Temelín NPP are also designed to be flood-resilient in case of a maximum one-day rainfall that leads to a maximum water level of 47.2 mm (in case of 100-year rainfall) and 88.1 mm (in case of 10,000-year rainfall), in case the sewer system is completely disabled. The location also contains mobile equipment of the fire rescue unit, which is adapted for pumping water from local floods in excess of 10,000-year values. Because flooding from external watercourses is inherently ruled out and the building objects in the Temelín NPP are designed to be resilient against floods even in the case of extreme rainfall (watertight lids, height of entry and installation openings), there is at least 100% reserve before reaching levels at which water would flood the buildings. Thanks to the gravity drainage of water from the location, this level cannot be reached. (National report, page 222).

At the end of 2017, all actions related to the above mentioned issues were completed.

Extreme weather conditions

For NPP Dukovany in the case of extreme wind with the time of re-occurrence of 10,000 years, the safety function of residual heat removal might be endangered. The main cause is that ventilator towers have not been installed in the ESW system and the main cooling towers are not sufficiently resistant to extreme wind. It was also discovered that, in the case of extreme wind occurrence, some significant safety civil structures are not sufficiently resistant;

however, detailed effects on the equipment concerned have not yet been analyzed. Possible damage to the fuel deposited in the reactor or in SFSP after the loss of the reactor hall's roof integrity due to extreme wind is highly improbable.
The most significant impact of extreme snow load might be fall of the turbine hall's roof, which might result in a loss of the safety systems located in the turbine hall. The most significant problems might be caused by failure of the ESW system, which might lead to risk to the function of long-term residual heat removal. This holds true on condition that preventive removal of snow off the turbine hall's roof fails. Some partial differences in the actual resistance of selected buildings from the required values of resistance under extreme load are addressed in the project of supplementary seismic qualification of the significant safety equipment in civil structures, which is being completed. Currently, review analyses are underway to re-prove sufficient resistance to the effects of climatic extremes for all civil structures, systems and components which ensure performance of the basic safety functions.
The assessment of extreme climatic phenomena was reduced only to the scope of significant safety civil structures and the equipment located therein. Therefore, it is necessary to assume that, in particular, an event such as extreme wind or extreme snow might result in damage to civil structures providing for auxiliary services. Such events might also cause the location's isolation and its inaccessibility for a period of several days. On the design basis, the Fire Brigade building (LFRU) is not classified as a significant safety building, therefore, it has not been assessed from the point of view of extreme natural conditions effects (extreme wind, extreme snow, earthquake). Therefore, it is not known whether the LFRU building might be damaged as a consequence of natural conditions. At the present time, analyses regarding the resistance of the LFRU building are being performed. (National report, page 93)

The design and diversity of the SSC of NPP Temelin ensure sufficient resiliency and reserves in case of extreme weather events. The possible adverse effects of extreme natural events could lead to shutdown of units, however they cannot pose a threat to the safety functions. The auxiliary functions could be influenced as a result of extreme natural events, e.g. in case the media in the bridge pipes freeze. The aim of the proposed measures is to further strengthen the defence-in-depth protection in case of extreme natural events. (National report, page 226)

At the end of 2017, all actions related to the above mentioned issues were completed.

3.1 Topic I – Natural hazards

3.1.1 Hazard Frequency

No.	Recommendations	Activity Action No.
Hazard Frequency The use a return frequency of 10E-4 per annum (0.1g minimum peak ground acceleration for earthquakes) for plant reviews/back-fitting with respect to external hazards safety cases.		
3.1.1.1	Recommendations from National Stress test Report	
3.1.1.1.1	**NPP Dukovany:** To complete the project of Dukovany NPP seismic upgrading. (tab.10)	**1**
3.1.1.1.2	**NPP Dukovany:** Control and ensuring of non-seismic equipment anchoring (tab.10)	**1**
3.1.1.1.3	**NPP Dukovany:** To work out earthquake operating regulations (tab.10)	**7, 52**
3.1.1.1.4	**NPP Dukovany:** EDMG instructions for use of alternative means (tab.10)	**52, 53**
3.1.1.1.5	**NPP Dukovany:** To ensure working of emergency response units in case of unavailability of ECC (tab.10)	**59**
3.1.1.1.6	**NPP Dukovany:** Seismic resistance of LFRU building (tab.10) Note:Mobile firemen equipment as temporary solution.	**3, 84**
3.1.1.1.7	**NPP Dukovany:** Alternative means of communications after a seismic event (tab.10)	**57**
3.1.1.1.8	**NPP Dukovany:** Analysis regarding threat to shelters on a seismic event (tab.10)	**59, 60**

3.1.1.1.9	**NPP Dukovany:** Ensuring of sufficient amount of staff after a seismic event (tab.10)	**37, 40**
3.1.1.1.10	**NPP Dukovany:** Access to buildings, availability of machinery (tab.10)	**53**
3.1.1.1.11	**NPP Temelin:** Alternative refuelling diesel using tank trucks for long-term operation of the DG (tab.30)	**22**
3.1.1.1.12	**NPP Temelin:** EDMG manuals for using alternative means. (tab.30)	**53**
3.1.1.1.13	**NPP Temelin:** OER (organization of emergency response) ability outside the ECC (emergency control centre) (tab.30)	**59**
3.1.1.1.14	**NPP Temelin:** Resilience of the LFRU (local fire rescue unit) to seismicity (tab.30) Note:Mobile firemen equioment as temporary solution.	**2, 84**
3.1.1.1.15	**NPP Temelin:** Alternative means of communication after a seismic event (tab.30)	**57**
3.1.1.1.16	**NPP Temelin:** Analysis of the threat to the shelters in case of a seismic event (tab.30)	**59, 60**
3.1.1.1.17	**NPP Temelin:** Security of the staff after a seismic event (tab.30)	**60**
3.1.1.1.18	**NPP Temelin:** Access to buildings, accessibility for heavy machinery (tab.30)	**53**
3.1.1.2	Recommendations from ENSREG Country Peer Review	
3.1.1.2.1	**NPP Dukovany:** During the plant visit it was explained that SSCs of safety classified systems reach resistance values between 0,11g and 0,169g. The upper resistance limits for circulation cooling water is given as 0.112g, based on the capability of the cooling towers. It is recommended that SUJB should consider ensuring enhanced capability for this function. (page 7)	**33**

3.1.1.2.2	**NPP Dukovany:** The upgrade program for Dukovany NPP is scheduled to be completed in 2015. It is recommended that SUJB should continue to monitor the ongoing earthquake resistance qualifications and reinforcements for the Dukovany NPP to ensure that all the safety related SSCs of the plant are resistant for at least 0.1 g PGA. It is also recommended that the proposed reinforcement should continue to be monitored by the national regulator. (page 8).	**1, 72**
3.1.1.2.3	**NPP Dukovany:** It is recommended that SUJB should consider how to monitor resolution of: • actions to increase the plant's capabilities to cope with the indirect effects of an earthquake and other external events • low seismic margins for cooling towers serving as heat sink for the ESW • low seismic capability for fire brigade building. (page 8)	**1st – 4, 70** **2nd – 33** **3rd – 3**
3.1.1.3	Luxembourg general peer review report	
3.1.1.3.1	Driving all plant reviews/back-fitting with respect to external hazards safety cases to the 10-4 per annum/0.1g minimum peak ground acceleration. (§5.3.1)	**1**
3.1.1.4	ENSREG - Follow - up fact finding site visit NPP Temelin	
3.1.1.4.1	Seismically qualifying the fire brigade building (page 3.)	**2**

3.1.2 Secondary Effects of Earthquakes

Secondary Effects of Earthquakes The possible secondary effects of seismic events, such as flood or fire arising as a result of the event, in future assessments.		**Activity Action No.**
3.1.2.1	Recommendations from National Stress test Report	
3.1.2.1.1	**NPP Dukovany:** Seismic PSA (tab.10)	**4 , 70 (PSR)**
3.1.2.2	Recommendations from ENSERG Country Peer Review	
3.1.2.2.1	**NPP Dukovany:** It is recommended that SUJB should consider how to monitor resolution of: • actions to increase the plant's capabilities to cope with the indirect effects of an earthquake and other external events (page 8)	**4, 70**
3.1.2.3	Luxembourg general peer review report	

3.1.2.3.1	Clarifying requirements for the approach to the secondary effects of seismic events, such as flood or fire arising as a result of the event, in future assessments. (§5.3.5)	**4, 70**

3.1.3 Protected Volume Approach

Protected Volume Approach The use a protected volume approach to demonstrate flood protection for identified rooms or spaces.		**Activity Action No.**
3.1.3.1	Luxembourg general peer review report	
3.1.3.1.1	Clarifying requirements for the approach to the secondary effects of seismic events, such as flood or fire arising as a result of the event, in future assessments. (§5.3.5) Temelin and Dukovany sites are not endangered by natural or specific floods. However, all buildings are designed with the respect to withstand extreme rainwater.	**4, 70**
3.1.3.1.2	That the protected volume approach is an effective way of demonstrating flood protection for identified rooms or spaces. (§ 5.3.6) All buildings were inspected and additional measures against extreme rainwater in selected buildings have been implemented.	**9, 10, 11**

3.1.4 Early Warning Notifications

Early Warning Notifications The implementation of advanced warning systems for deteriorating weather, as well as the provision of appropriate procedures to be followed by operators when warnings are made.		**Activity Action No.**
3.1.4.1	Luxembourg general peer review report	
3.1.4.1.1	That some countries refer to weather alert systems. Advance warning of deteriorating weather is often available in sufficient time to provide the operators with useful advice and national regulators should ensure that appropriate communications and procedures are developed by all operators.(§ 5.3.11)	**5**

3.1.5 Seismic Monitoring

Seismic Monitoring The installation of seismic monitoring systems with related procedures and training.		**Activity Action No.**
3.1.5.1	Recommendations from ENSREG Country Peer Review	
3.1.5.1.1	**NPP Dukovany:** During the PSR process a re-evaluation against 0,1g PGA for Dukovany NPP, in line with IAEA guidance has been introduced. During the country visit it was explained that work has been carried out to evaluate the seismic hazard using modern methods taking account of recent paleoseismological and geodetic data. This SHA is still to be validated and it is recommended that SUJB considers the implications during the PSR process. (page 8.)	**45**
3.1.5.2	Luxembourg general peer review report	
3.1.5.2.1	Installation of seismic monitoring systems and development of associated procedures and training for those NPPs that currently do not have such systems. (§5.3.10) Internal seismic monitoring system is implemented at Temelin NPP.	**6**

3.1.6 Qualified Walkdowns

Qualified Walkdowns The development of standards to address qualified plant walkdowns with regard to earthquake, flooding and extreme weather – to provide a more systematic search for non-conformities and correct them (e.g. appropriate storage of equipment, particularly for temporary and mobile plant and tools used to mitigate beyond design basis (BDB) external events).		**Activity Action No.**
3.1.6.1	Luxembourg general peer review report	

3.1.6.1.1	How best to ensure that specific operational requirements of external events safety cases are adequately maintained. Regulators and operators should consider developing standards to address qualified plant walkdowns with regards to earthquake, flooding and extreme weather – to provide a more systematic search for non-conformities and correct them (e.g. appropriate storage of equipment, particularly for temporary and mobile plant and tools used to mitigate BDB external events). This plant-based activity would benefit from clear labelling of qualified equipment. (§ 5.3.7) Extraordinary inspections (during May, 2011) of plant resistance against internal and external floods were conducted. No significant discrepancy of current status with design requirements have been identified at Temelin NPP and only minor discrepancies of current status with design requirements have been identified at Dukovany NPP that were immediately corrected.	**7, 8, 52**

3.1.7 Flooding Margin Assessments

Flooding Margin Assessments The analysis of incrementally increased flood levels beyond the design basis and identification of potential improvements, as required by the initial ENSREG specification for the stress tests.		**Activity Action No.**
3.1.7.1	Recommendations from National Stress test Report	
3.1.7.1.1	**NPP Dukovany:** EDMG instructions for use of alternative means (tab.11)	**53**
3.1.7.1.2	**NPP Dukovany:** Analysis regarding threat to shelters in the case of floods (tab.11)	**9, 60**
3.1.7.1.3	**NPP Temelin:** Increasing the resilience of the DG in case of external flooding (tab.31)	**9**
3.1.7.1.4	**NPP Temelin:** Ability of the OER to function via the ECC (tab.31)	**59**
3.1.7.1.5	**NPP Temelin:** EDMG manuals for using alternative means (tab.31)	**53**
3.1.7.1.6	**NPP Temelin:** Analysis of the threat to the shelters in case of floods (tab.31)	**9, 60**
3.1.7.2	Recommendations from ENSREG Country Peer Review	

3.1.7.2.1	**NPP Temelin:** Increasing the protection of the diesel fuel pumps against the effects of flooding and also an alternative shelter is to be set up for the emergency response organization when the dedicated emergency response centre is damaged due to some external hazard. (page 10)	**9**
3.1.7.2.2	**NPP Temelin:** Convincing information is provided that the flooding from external water courses is "inherently ruled out" and the possible maximum flooding due to extreme rainfall is limited due to the morphological characteristics of the sites. At the same time there is a proposed measure for the Temelin site that the resilience of the emergency diesel generators should be increased, with a reference to the latest PSR. (page 10)	**9**
3.1.7.2.3	**For both NPPs:** The main requirement is that the SSCs necessary for safe shutdown of the plant need to remain operational after any possible flood situation. (page 9.)	**9, 10, 11**
3.1.7.2.4	**For both NPPs:** Some modifications to emergency procedures and analyses regarding the usability of the shelters under flooding conditions are foreseen. (page 10)	**9, 60**
3.1.7.3	Luxembourg general peer review report	
3.1.7.3.1	That in all countries that have not considered incrementally increased flood levels and associated potential improvements they should consider requiring the operators to do so. (§ 5.3.2)	**7, 8, 9, 10, 11**
3.1.7.4	ENSREG -Follow-up fact finding site visit NPP Temelin	
3.1.7.4.1	Increasing the protection of the diesel fuel tanks against the effects of flooding (with a reference to the latest PSR) (page 3.)	**9**
3.1.7.4.2	Increase resistance against rainfall of several buildings (DG´s building and emergency shelter) (page 3.)	**9**
3.1.7.4.3	Setting up an alternative shelter for the emergency response organization (e.g. when the dedicated emergency response centre is damaged due to some external hazard – like flooding) (page 3.)	**60**

3.1.8 External Hazard Margins

External Hazard Margins In conjunction with recommendation 1 and 17, the formal assessment of margins for all external hazards including, seismic, flooding and severe weather, and identification of potential improvements. Licensing basis protection against external hazards (e.g. flood seals and seismic supports) should be verified to be effective. Margin assessments should be based on periodic re-evaluation of licensing basis for external events considering possible cliff-edge effects and grace periods.		**Activity Action No.**
3.1.8.1	Recommendations from National Stress test Report	
3.1.8.1.1	**NPP Dukovany:** To implement measures for diversion means of the ultimate heat sink (to CT). (tab.15)	**33**
3.1.8.1.2	**NPP Dukovany:** To work out operating regulations for extreme events (wind, temperature, snow) (tab.15)	**7**
3.1.8.1.3	**NPP Dukovany:** EDMG instructions for use of alternative means (tab.15)	**53**
3.1.8.1.4	**NPP Dukovany:** Ensuring of sufficient number of staff after extreme events (tab.15)	**40**
3.1.8.1.5	**NPP Dukovany:** Resistance of civil structures (LFRU, CPS, MPU etc.) to extreme conditions (tab.15)	**1, 3**
3.1.8.1.6	**NPP Dukovany:** To work out methods of evaluation of external effects, verification of analyses performed, possible technical measures (tab.15)	**12**
3.1.8.1.7	**NPP Temelin:** Alternative supply of diesel fuel from the tank for long-term operation of the DG. (tab.33)	**22**
3.1.8.1.8	**NPP Temelin:** Ensuring safety and operational staff in case of extreme events (tab.33)	**40**
3.1.8.1.9	**NPP Temelin:** Executing methodology for assessing external effects, verification of analyses carried out, possible technical measures (tab.33)	**12**
3.1.8.2	Recommendations from ENSREG Country Peer Review	

3.1.8.2.1	**NPP Dukovany:** There is a reference to the Dukovany PSR in relation to ensuring separation of safety systems from systems for normal operation used for ultimate heat sink because of the inadequate capability of the cooling towers in regard to extreme wind. Possibilities include using separate cooling towers or sprinkler pools for ESW heat sink. It is recommended that the SUJB considers how to ensure that this issue is effectively resolved and appropriate improvements incorporated. (page 11)	**33**
3.1.8.2.2	**For both NPPs:** In the stress test process it has been identified that the procedures for special handling of weather related threats need to be elaborated and some specific additions might be necessary to the emergency management procedures. The organizational arrangements to ensure the necessary staff in case of lasting extreme weather conditions have to be elaborated. The considerations for extreme low temperatures may be too simple, not taking into account the realistic related effects, e.g. station black-out. Some refined further analyses and verification of current analyses are judged to be necessary. The elaboration of diverse connection to the ultimate heat sink and the load analyses of specific civil structures are already in progress and it is recommended that the SUJB should ensure that the question of diverse ultimate heat sink is resolved effectively. (page 11)	**12, 33, 40**
3.1.8.3	Luxembourg general peer review report	
3.1.8.3.1	Strengthening the PSR process by encouraging a more consistent approach to the determination of margins for external events, including external event PSAs (including seismic) and regular reviews of the design and beyond design hazards. (§ 5.3.3)	**4, 69, 70**
3.1.8.3.2	That with regard to hazard definition, techniques and data are still developing. WENRA, involving the best available expertise from Europe, should develop guidance on natural hazards assessments, including earthquake, flooding and extreme weather conditions, as well as corresponding guidance on the assessment of margins beyond the design basis and cliff edge effects. (§5.3.4)	**12**
3.1.8.4	ENSREG -Follow-up fact finding site visit NPP Temelin	
3.1.8.4.1	Elaboration of procedures for special handling of weather related threats with some specific additions to the emergency management procedures. (e.g. organizational arrangements to ensure the necessary staff in case of lasting extreme weather conditions) (page 3.)	**7, 8, 12, 40, 52**
3.1.8.5	Final Summary Report of the 2nd Extraordinary Meeting of the Contracting Parties to the CNS	
3.1.8.5.1	Re-evaluating the hazards posed by external events, such as earthquakes, flood and extreme weather conditions, for each nuclear power plant site through targeted reassessment of safety. (page 5.)	**45, 70**

3.2 Topic 2 - Loss of safety systems

Loss of AC/DC power

NPP Dukovany electrical systems fulfil the requirements of the machine-nuclear part and respect the properties of the electricity network outside NPP, particularly with respect to NPP Dukovany operational safety and the production of electricity. Ensuring safety in the case of a breakdown in the supply of electricity is ensured by the high level of mutual independence of both working and reserve house consumption resources and the redundancy of the secure power supply system (SSPS), which supply key safety systems and components and have their own emergency resources. The NPP Dukovany house consumption distribution network is supplied from diversified working, reserve and emergency electricity resources.
(National report, page 95.)

Despite the robust defense-in-depth exists against total loss of power supply, areas for improvement of resistance against SBO have been identified for cases of concurrent failure of all defense-in-depth levels of electric power supply. (National report, page 104, tab. 16.) These areas were primary source for actions in the NAcP.

Electrical systems in the Temelín NPP were designed to comply with the requirements of the mechanic-nuclear part and respect the properties of the off-site power grid, especially with respect to the safety of operation of the Temelín NPP and production of electricity.
The safety of the Temelín NPP in case of a loss of power was handled in the design by a high degree of diversification of the operating and reserve sources for house consumption, as well as by the redundancy and diversification of the secure power supply systems (SPSS), which contain own emergency sources and supply not only safety systems, but also safety related and other important systems and components of both units. The power supply for house consumption is separate for each unit in order to prevent the spreading of electrical disturbances. (National report, page 228.)

Despite the robust defense-in-depth exists against total loss of power supply, areas for improvement of resistance against SBO have been identified for cases of concurrent failure of all defense-in-depth levels of electric power supply. (National report, page 246, tab. 34). These areas were primary source for actions in the NAcP.

At the end of 2017, all actions related to the above mentioned issues were completed.

Loss of UHS

The ultimate heat sink of heat released from the fuel of NPP Dukovany units is represented by the surrounding atmosphere. Unused heat during the production mode of the unit or residual heat after reactor shutdown is transferred into the ultimate heat sink in several ways:

a) Through the secondary circuit by means of the system for condensing and the circulating cooling water – in normal and abnormal operation in the production mode, in starting and disconnection of TG and in the emergency mode after disconnection of the reactor if working or reserve supply sources are ensured. This method does not ensure the transfer of the reactor into a cold status.

b) Using the system for cooling and delivery of heat into essential technical water (ESW) – at normal and abnormal operation and under emergency conditions, it is possible to transfer the reactor into a cold status (about 50 °C in RC and in SFSP).

c) By direct release of steam into the atmosphere from SG while filling SG with supply water – under abnormal or emergency operation; it is not possible to transfer the reactor into a cold status (cooling-down max. to 110 °C).

d) The alternative method of additional cooling in the case of not enabling the natural circulation of the coolant in loops, by the feed&bleed method on the primary circuit (PSV + ECCS) with the heat removal into essential technical water – this strategy is used in all cases of the loss of the heat removal through the secondary circuit. The heat from RC is transferred directly into containment from which, through the ECCS system (pumps TH,TQ and cooler TQ) is removed by the ESW system into the atmosphere. In terms of the function and the loss of the ultimate sink, this method is at the same level as the heat removal by the ESW system in the cooling-down process (similar to b). (National report, page 105).

Despite the robust defense-in-depth system exists against loss of heat removal to the ultimate heat sink, areas for improvement of resistance against loss of UHS have been identified for cases of concurrent failure of all defense-in-depth levels of UHS. (National report, page 110, tab. 17). These areas were primary source for actions in the NAcP.

The ultimate heat sink for both units of the Temelín NPP is also ensured by the atmosphere. Unused heat from operation at power of the units or residual heat from the core after shutdown, can be removed to the ultimate heat sink in several ways:

a) Transfer of heat via the TG condensation system into the circulation cooling water and via cooling towers into the atmosphere – under normal and abnormal power operation, start-up as well as shutdown of the TG and under emergency conditions after the reactor was shut down, provided that working or reserve sources of power supply are available.

b) Transfer of residual heat from the core and components of safety systems using the essential service water system into the cooling basins with spraying system and from there into the atmosphere – under normal and abnormal operation and in emergencies, with the possibility of bringing the reactor into a cold state.

If operating means of heat transfer into the ultimate heat sink are unavailable, it is possible to employ alternative methods of heat transfer:

a) Direct transfer of heat by releasing steam from the SG into the atmosphere while adding supply water – in abnormal or emergency operation; this variant allows long-term removal of heat from the core, but does not allow cooling-down the reactor to a cold state (cooling-down to approximately 110 ^{o}C).

b) Alternative “feed and bleed” method (controlled discharge of coolant from the I.C into the containment, transfer of heat via ECCS exchangers into the ESW and supply of cooled coolant using ECCS pumps into the I.C – only in emergency conditions when it is impossible to use a secondary transfer of heat. (National report, page 238).

Desipte the robust defense-in-depth system exists against loss of heat removal to the ultimate heat sink, areas for improvement of resistance against loss of UHS have been identified for cases of concurrent failure of all defense-in-depth levels of UHS. (National report, page 246, tab. 34). These areas were primary source for actions in the NAcP.

At the end of 2017, all actions related to the above mentioned issues were completed.

Loss of UHS combined with SBO

The functions of power supply from emergency sources and heat transfer to the ultimate heat sink are closely related and loss of one of the functions may affect the other function and vice versa. Although multiple failures of defense-in-depth levels would have to occur before the loss of both functions, considering severity of consequences of such conditions additional measures have been proposed in order to improve even so robust design with regard to heat transfer to atmosphere as the ultimate heat sink. The measures to enhance the robustness of the units in case of SBO combined with the loss of UHS are the same as the measures identified in case of SBO and in case of the loss of UHS.

The goal of the proposed short-term measures is to eliminate identified risks by strengthening defense-in-depth protection levels in case of initiation events beyond the framework of the current design (earthquake, floods, extreme conditions, results of human interference, etc.) that could result in a loss of the ability to perform the safety functions during an SBO in combination with a loss of UHS. (National report, page 114, tab. 18 (Temelín NPP), respectively page 246, tab. 34 (Dukovany NPP)).

At the end of 2017, all actions related to the above mentioned issues were completed.

3.2 Topic 2 - Loss of safety systems

3.2.1 Alternate Cooling and Heat Sink

Alternate Cooling and Heat Sink The provision of alternative means of cooling including alternate heat sinks.		**Activity Action No.**
3.2.1.1	Recommendations from National Stress test Report	
3.2.1.1.1	**NPP Dukovany:** Ensuring additional source for adding water into SG. (tab.17)	**13**
3.2.1.1.2	**NPP Dukovany:** Analysis of possibility of alternative adding of water into the reactor by pump and new pipeline (tab.17)	**15**
3.2.1.1.3	**NPP Dukovany:** Implementation of measures for diversified means of the ultimate heat sink (to CT) (tab.17)	**33**
3.2.1.1.4	**NPP Dukovany:** Preparation of the procedure for the loss of UHS and ESW systems on all 4 units (tab.17)	**33**
3.2.1.1.5	**NPP Dukovany:** Completion of the existing regulations with the procedure for filling SG of all four units by fire extinguishing technology (tab.17)	**13, 53, 55**
3.2.1.1.6	**NPP Dukovany:** The existing regulations prefer the way of filling the open reactor and SFSP with self-gravitation from XL trays (tab.17)	**15**
3.2.1.1.7	**NPP Dukovany:** The collection of cooling from SFSP by adding coolant and accumulation in TH tanks (tab.17)	**15**
3.2.1.1.8	**NPP Dukovany:** EDMG manuals for the use of alternative means (tab.17)	**53**
3.2.1.1.9	**NPP Dukovany:** Ensuring additional supply source for systems SPS I. category and selected consumer appliances SPS II. category. (tab.18)	**18**
3.2.1.1.10	**NPP Dukovany:** Production of the procedure for restoration of SBO supply for all units (tab.18)	**18, (41)**

3.2.1.1.11	**NPP Temelin:** Alternative water supply for SG/SFSP/I.C (in case of I.C leakage). (tab.34)	**16**
3.2.1.1.12	**NPP Temelin:** Analysis of heat transfer from the I&C after losing the ESW (tab.34)	**26**
3.2.1.1.13	**NPP Temelin:** Procedure for restoring the power supply after an SBO in all units (tab.34)	**18, (41)**
3.2.1.1.14	**NPP Temelin:** EDMG manuals for using alternative means (tab.34)	**53**
3.2.1.2	Recommendations from ENSREG Country Peer Review	
3.2.1.2.1	**NPP Dukovany** There is a reference to the Dukovany PSR in relation to ensuring separation of safety systems from systems for normal operation used for ultimate heat sink because of the inadequate capability of the cooling towers in regard to extreme wind. Possibilities include using separate cooling towers or sprinkler pools for ESW heat sink. It is recommended that the SUJB considers how to ensure that this issue is effectively resolved and appropriate improvements incorporated. (page 11.)	**33**
3.2.1.2.2	**NPP Dukovany:** In Dukovany NPP there are 4 wet cooling towers for twin units, which serve as heat sink for service water and also for essential service water (TVD) systems. Cooling towers are not qualified as safety components. This issue was recognized during the last periodic safety review in 2009, and is being addressed by the project "Separation of safety systems from operational systems" (No. 5983). As it was discussed during the country visit, this safety improvement project is currently in design phase; the hardware modification is scheduled from 2015 to 2017. It is recommended, that the regulator considers how to ensure this is resolved effectively. (page 15.)	**33**
3.2.1.2.3	**NPP Dukovany:** • Specific possible safety improvements for Dukovany NPP related to the loss of UHS: Implement diverse (to the cooling tower) UHS means • Develop a procedure for the loss of UHS and ESW systems in all 4 units • Develop a procedure for the refilling of steam generators using fire fighting equipment • Filling an open reactor and spent fuel pool (SFP) by gravity drainage from bubbler trays • Removal of heat from the coolant in the SFP by means of coolant replenishment and its accumulation in emergency cooling water tanks (TH-system) • Extensive damage mitigation guidelines for the use of alternative means (page 17.)	**33** **53** **13** **15** **15** **53**

3.2.1.2.4	**NPP Dukovany:** In general there is redundancy and diversity in the electric and cooling capabilities to ensure safety functions, however additional alternate heat sink has not be implemented in Dukovany NPP. Besides that there are plans to increase system robustness to cope with SBO and LUHS. SUJB should follow the diversification of ultimate heat sink in Dukovany and the application of means and procedures to improve battery discharge time and makeup of steam generators. (page 17.)	**33, 20, 13, 17**
3.2.1.2.5	**NPP Temelin:** In Temelin NPP enough fire trucks are present, however no water connection points are available on relevant systems of the units. Safety improvement measure was decided by the licensee to resolve this issue. It was clarified during the country visit that the first phase of system modification will be realized in 2012, and the full implementation is planned in 2013. SUJB should consider to follow up the implementation (page 16)	**14**
3.2.1.2.6	**NPP Temelin:** • Specific possible safety improvements for Temelín NPP related to the loss of UHS: • Install new hook up points for fire trucks • Develop a procedure for the loss of UHS and ESW systems in both units • Extensive damage mitigation guidelines for the use of alternative means • Alternative replenishment of water to steam generator/SFP/primary circuit (with unsealed primary circuit) • Analysis of heat removal from I&C systems following a loss of ESW (page 17.)	**14** **53** **53** **14, 16** **26**
3.2.1.2.7	**For both NPPs:** In the stress test process it has been identified that the procedures for special handling of weather related threats need to be elaborated and some specific additions might be necessary to the emergency management procedures. The organizational arrangements to ensure the necessary staff in case of lasting extreme weather conditions have to be elaborated. The considerations for extreme low temperatures may be too simple, not taking into account the realistic related effects, e.g. station black-out. Some refined further analyses and verification of current analyses are judged to be necessary. The elaboration of diverse connection to the ultimate heat sink and the load analyses of specific civil structures are already in progress and it is recommended that the SUJB should ensure that the question of diverse ultimate heat sink is resolved effectively. (page 11.)	**7** **8** **52**

3.2.1.2.8	**For both NPPs:** It is recommended, that the SUJB consider how to monitor the licensee in respect: • to ensure that the new safety related equipment has beyond design basis capability for hazards. • to increase the plant robustness by implementation of alternative means for AC power supply for core cooling and heat removal • to improve the battery depletion time and implement battery recharging • to provide additional fire truck (Dukovany NPP) • to install hook up points for steam generator water make-up at Temelin NPP (page 17.)	**13 – 27** **18, 19** **18, 19** **78** **14**
3.2.1.3	Luxembourg general peer review report	
3.2.1.3.1	Using alternative means of cooling including alternate heat sinks. SG gravity feeding, or using other sources of water, supply from stored condenser cooling water, alternate tanks or wells on the site, or water sources in the vicinity (reservoir, lakes, etc) is an additional way of enabling core cooling and prevention of fuel degradation. Some plants identified possible actions, including additional analysis that might be needed. (§ 6.3.2)	**73** **15, 16** **38, 39** **40, 41** **42, 43**
3.2.1.4	ENSREG -Follow-up fact finding site visit NPP Temelin	
3.2.1.4.1	Installing new hook up points for fire trucks (page 3.)	**14**

3.2.2 AC Power Supplies

AC Power Supplies The enhancement of the on-site and off-site power supplies.		**Activity Action No.**
3.2.2.1	Recommendations from National Stress test Report	
3.2.2.1.1	**NPP Dukovany:** Ensuring additional supply source for systems SPS I. category and selected consumer appliances SPS II. category. (tab.16)	**18**
3.2.2.1.2	**NPP Dukovany:** Elaboration of a procedure for restoration of SBO supply for all units (tab.16)	**18, 53**
3.2.2.1.3	**NPP Dukovany:** Elaboration of a procedure for filling of SG of all four units by fire extinguishing technology (tab.16)	**13**
3.2.2.1.4	**NPP Dukovany:** Ensuring alternative source of electricity for shelters and telephone exchanges (tab.16)	**18, 34**

3.2.2.1.5	**NPP Dukovany:** Ensuring alternative source of electricity for the TSPP supply (tab.16)	**18**
3.2.2.1.6	**NPP Dukovany:** Ensuring sufficient personnel during long-term SBO (tab.16)	**40**
3.2.2.1.7	**NPP Dukovany:** Ensuring the functioning of emergency response organization in the case of non-accessibility of ECC (tab.16)	**59, 60**
3.2.2.1.8	**NPP Temelin:** Securing a sufficient number of staff in case of a long-term SBO (tab.34)	**41**
3.2.2.1.9	**NPP Temelin:** Analyses of the possibility of shift staff in case of an SBO in both units (tab 34.)	**41**
3.2.2.1.10	**NPP Temelin:** Alternative sources and means of communication after a seismic event (tab. 34)	**35, 57, 59**
3.2.2.1.11	**NPP Temelin:** Elaboration of a procedure for the operation of units in case of a long-term power supply from emergency sources (tab.34)	**53**
3.2.2.2	Recommendations from ENSREG Country Peer Review	
3.2.2.2.1	**For both NPPs:** It is recommended, that the SUJB consider how to monitor the licensee in respect: • to increase the plant robustness by implementation of alternative means for AC power supply for core cooling and heat removal to improve the battery depletion time and implement battery recharging. (page 17.)	**18, 19, 20, 21**
3.2.2.3	Luxembourg general peer review report	
3.2.2.3.1	Backup (SBO) DG installation (page 29.)	**18, 19**
3.2.2.3.2	Analysis of off-site power supply robustness, subsequent enhancements (if found feasible) (page 29)	**74**

3.2.3 DC Power Supplies

	DC Power Supplies The enhancement of the DC power supply.	**Activity Action No.**
3.2.3.1	Recommendations from National Stress test Report	

3.2.3.1.1	**NPP Dukovany:** Analysis of the discharging time of accumulator batteries in case of controlled releasing of the load, revision of OIs , changing the connection and operation of emergency lighting (including replacement of light bulbs by energy saving lamps) (tab.16)	**20, 75**
3.2.3.1.2	**NPP Temelin:** Alternative source for recharging accumulator batteries and supplying selected appliances (tab.34)	**21**
3.2.3.1.3	**NPP Temelin:** Using the safety DG of the other unit in case of an SBO (tab.34)	**79**
3.2.3.1.4	**NPP Temelin:** Analysis of the discharging period of the accumulator batteries in case of a controlled reduction of the load, details on procedures (including replacement of light bulbs by energy saving lamps) (tab.34)	**21, 75**
3.2.3.2	Recommendations from ENSREG Country Peer Review	
3.2.3.2.1	**NPP Dukovany:** The capacity of the accumulator battery sets of Dukovany secured power supply SPSS 1, 2 and 3 is 1500 Ah. According to the design, the discharge time of accumulator batteries with the maximum conservative load is at least 2 hours. Procedures have been developed to reduce the less important loads and saving of DC capacity. The real depletion time may be much longer than two hours (6 to 8 hours). Based on the fact that battery depletion is an important cliff edge effect, further improvements are under consideration. It is recommended, that the regulator considers how to ensure this is resolved effectively. (page 15.)	**18, 20**
3.2.3.2.2	**NPP Temelin:** Temelin NPP is equipped with 3x1600 Ah batteries for power supply of safety systems and 2x2400 Ah batteries for safety related consumers. The discharge time for these batteries is also at least 2 hours. Currently, recharging of the accumulator batteries during SBO is not provided. If the power supply can't be restored within 2 hours, the operating personnel will lose the information on plant parameters and hence this is the first cliff-edge effect in case of SBO. For that purpose an improvement measure is proposed for ensuring an alternative source for battery recharging. (page 15.)	**19, 21**
3.2.3.2.3	**For both NPPs:** It is recommended, that the SUJB consider how to monitor the licensee in respect: • to increase the plant robustness by implementation of alternative means for AC power supply for core cooling and heat removal to improve the battery depletion time and implement battery recharging. (page 17.)	**19** **21**
3.2.3.3	ENSREG -Follow-up fact finding site visit NPP Temelin	

3.2.3.3.1	Improving the battery depletion time and implement battery recharging by SBO DG (page 4.)	**19, 21**

3.2.4 Operational and Preparatory Actions

Operational and Preparatory Actions Implementation of operational or preparatory actions with respect to the availability of operational consumables.		**Activity Action No.**
3.2.4.1	Recommendations from National Stress test Report	
3.2.4.1.1	**NPP Temelin:** Alternative supply of diesel fuel from a tank truck for long-term operation of the DG (tab.34)	**22**
3.2.4.2	Luxembourg general peer review report	
3.2.4.2.1	Operational or preparatory actions such as ensuring the supply of fuel and lubrication oil, battery load-shedding to extend battery life are examples of measures that are small (in many cases procedural) but that could make a considerable difference in response to initiators. All in all, most of the plants have already considered these measures and might be adding to them in the future. (§6.3.3)	**22**
3.2.4.3	ENSREG -Follow-up fact finding site visit NPP Temelin	
3.2.4.3.1	Developing procedures for complex accidents (e.g. loss of UHS and ESW systems, procedure for the alternative replenishment of water to steam generator/SFP/primary circuit (with unsealed primary circuit, use of mobile DGs during SBO's, long term DG operation.) (page 3.)	**53**

3.2.5 Instrumentation and Monitoring

Instrumentation and Monitoring The enhancement of instrumentation and monitoring.		**Activity Action No.**
3.2.5.1	Luxembourg general peer review report	
3.2.5.1.1	Safety improvements could be achieved and robustness strengthened by installing additional power sources and / or additional instrumentation that is based on simple physical principles (e. g. passive temperature, pressure readers).	**19, 21, 23, 24, 27**

3.2.6 Shutdown Improvements

Shutdown Improvements The enhancement of safety in shutdown states and mid-loop operation.		**Activity Action No.**
3.2.6.1	Recommendations from National Stress test Report	
3.2.6.1.1	**NPP Dukovany:** Prepare "shutdown SAMG" for shutdown / Severe accident in SFSP (tab.22)	**56**
3.2.6.1.2	**NPP Temelin:** Procedure for the isolation of the containment when in shutdown (tab.34)	**56**
3.2.6.1.3	**NPP Temelin:** Elaborate "SAMG shutdown" (fuel degradation with open reactor/in SFSP) (tab.36)	**56**
3.2.6.2	Recommendations from ENSREG Country Peer Review	
3.2.6.2.1	**For both NPPs:** Development of SAMGs for shutdown modes including open reactor and SFP accidents; (page 25.)	**56**
3.2.6.3	Luxembourg general peer review report	
3.2.6.3.1	Robustness could be increased through a systematic analysis of the shutdown state/mid-loop operation, in order to reduce or inhibit this operating mode and/or increase safety by adding dedicated hardware or procedures/drills (page 30).	**28**

3.2.7 Reactor Coolant Pump Seals

Reactor Coolant Pump Seals The use of temperature-resistant (leak-proof) primary pump seals. Study of RCP pump seal leakage following long term AC power failure.		**Activity Action No.**
3.2.7.1	Luxembourg general peer review report	
3.2.7.1.1	Considering the use of temperature-resistant (leak-proof) primary pump seals in some of the designs (page 30.) Sealing of the RCPs is assured by high pressure water dependent on AC/DC power supplies. The existing studies of seals behaviour in case of loss of AC/DC confirmed long-term RCP seals tightness for VVER type RCPs.	**80**

3.2.8 Ventilation

Ventilation The enhancement of ventilation capacity during SBO to ensure equipment operability.		**Activity Action No.**
3.2.8.1	Recommendations from National Stress test Report	
3.2.8.1.1	**NPP Temelin:** Analysis of heat transfer from the I&C after losing the ESW (tab.34)	**25, 26, 29, 30**
3.2.8.2	Recommendations from ENSERG Country Peer Review	
3.2.8.2.1	**NPP Temelin:** Analysis of heat removal from I&C systems following a loss of ESW (page 17.)	**25, 26, 29, 30**
3.2.8.3	ENSREG -Follow-up fact finding site visit NPP Temelin	
3.2.8.3.1	Analysis of the heat removal from I&C systems following a loss of ESW (page 3.)	**25, 26, 29, 30**

3.2.9 Main and Emergency Control Rooms

Main and Emergency Control Rooms The enhancement of the main control room (MCR), the emergency control room (ECR) and emergency control centre (ECC) to ensure continued operability and adequate habitability conditions in the event of a station black-out (SBO) and in the event of the loss of DC (this also applies to Topic 3 recommendations). Habitability of control rooms/emergency centres under DEC conditions.		**Activity Action No.**
3.2.9.1	Recommendations from National Stress test Report	
3.2.9.1.1	**NPP Temelin:** Analysis of the radiation situation in the CR/ ECR in case of a severe accident (tab.36)	**58**
3.2.9.2	Recommendations from ENSREG Country Peer Review	
3.2.9.2.1	**For both NPPs:** The main control rooms (MCR) and the emergency control rooms (ECR) are equipped with emergency filtered ventilation systems and are shielded and protected sufficiently against radiation. The habitability of the MCR and ECR in case of containment failure during a severe accident has not been analysed. Finally, it is recognized that not all systems used under SAM are designed to withstand earthquakes. It is recommended that the seismic resistance of the systems used for severe accident management should be further analysed. (page 21.)	**31, 58**

	Additional power sources and ventilation systems will be implemented at Dukovany and Temelin NPPs to ensure continued operability and adequate habitability conditions in the event of a station black-out.	

3.2.10 Spent Fuel Pool

Spent Fuel Pool The improvement of the robustness of the spent fuel pool (SFP).		**Activity Action No.**
3.2.10.1	Recommendations from National Stress test Report	
3.2.10.1.1	**NPP Dukovany:** The existing procedures prefer the way of filling the open reactor and SFSP by self-gravitation from XL trays (tab.17)	**15**
3.2.10.1.2	**NPP Dukovany:** Heat removal from SFSP by adding coolant and its accumulation in TH tanks (tab.17)	**15**
3.2.10.1.3	**NPP Dukovany:** Prepare "shutdown SAMG" for shutdown / Severe accident in SFSP (tab.21)	**56**
3.2.10.1.4	**NPP Dukovany:** Completion of measurements of the Ra situation and the status of SFSP (tab.21)	**27**
3.2.10.1.5	**For both NPPs:** Alternative water supply for SG/SFSP/I.C (in case of I.C leakage) (tab.34)	**15**
3.2.10.1.6	**NPP Temelin:** Transfer of heat from the SFSP without an additional water supply (tab.34)	**81**
3.2.10.1.7	**NPP Temelin:** Elaborate "SAMG shutdown" (fuel degradation in open reactor/in SFSP) (tab.36)	**56**
3.2.10.2	Recommendations from ENSREG Country Peer Review	
3.2.10.2.1	**NPP Dukovany:** Filling an open reactor and spent fuel pool (SFP) by gravity drainage from bubbler condenser trays (page 17.)	**15**
3.2.10.2.2	**NPP Dukovany:** Removal of heat from the coolant in the SFP by means of coolant replenishment and its accumulation in emergency cooling water tanks (TH-system)	**15**

3.2.10.2.3	**NPP Dukovany:** Extensive damage mitigation guidelines for the use of alternative means	**53**
3.2.10.2.4	**NPP Dukovany:** Improvement of the crisis plans and SAM documentation (e.g., providing SAMG for shutdown states and spent fuel pool accidents) (page 23.)	**56**
3.2.10.2.5	**NPP Temelin:** Alternative replenishment of water to steam generator/SFP/primary circuit (with unsealed primary circuit) (page 17.)	**16**
3.2.10.2.6	**For both NPPs:** Accidents during shutdown states and occurring at the SFP are not addressed in the existing SAMGs, but will be available by 2014. It is recommended that SUJB considers how to monitor the implementation. (page 26.)	**56**
3.2.10.3	Final Summary Report of the 2nd Extraordinary Meeting of the Contracting Parties to the CNS	
3.2.10.3.1	Installing additional equipment and instrumentation in spent fuel pools to ensure cooling can be maintained or restored in all circumstances, or performing additional technical evaluations to determine if additional equipment and instrumentation are needed. (page 6.)	**27, 32**

3.2.11 Separation and Independence

Separation and Independence The enhancement of the functional separation and independence of safety systems.		**Activity Action No.**
3.2.11.1	Recommendations from National Stress test Report	
3.2.11.1.1	**NPP Dukovany:** Implementation of measures for diversified means of the ultimate heat sink (to CT) (tab.17)	**33**
3.2.11.2	Recommendations from ENSREG Country Peer Review	

3.2.11.2.1	**NPP Dukovany:** In Dukovany NPP there are 4 wet cooling towers for twin units, which serve as heat sink for service water and also for essential service water (TVD) systems. Cooling towers are not qualified as safety components. This issue was recognized during the last periodic safety review in 2009, and is being addressed by the project "Separation of safety systems from operational systems" (No. 5983). As it was discussed during the country visit, this safety improvement project is currently in design phase; the hardware modification is scheduled from 2015 to 2017. It is recommended, that the regulator considers how to ensure this is resolved effectively. (page 15.)	**33**
3.2.12 Flow Path and Access Availability		
Flow Path and Access Availability The verification of assured flow paths and access under SBO conditions. Ensure that the state in which isolation valves fail and remain, when motive and control power is lost, is carefully considered to maximise safety. Enhance and extend the availability of DC power and instrument air (e. g. by installing additional or larger accumulators on the valves). Ensure access to critical equipment in all circumstances, specifically when electrically operated turnstiles are interlocked.		**Activity Action No.**
3.2.12.1	Recommendations from National Stress test Report	
3.2.12.1.1	**NPP Dukovany:** Ensuring alternative source of electricity for shelters and telephone exchanges (tab.16)	**34**
3.2.12.1.2	**NPP Dukovany:** Ensuring sufficient personnel during long-term SBO (tab.16)	**37, 40**
3.2.12.1.3	**NPP Temelin:** Securing a sufficient number of staff in case of a long-term SBO (tab.34)	**36, 41**
3.2.12.2	ENSREG -Follow-up fact finding site visit NPP Temelin	
3.2.12.2.1	Valves power reconnection to batteries for containment isolation during SBO (page 4.)	**82**
3.2.12.3	Luxembourg general peer review report	
3.2.12.3.1	Robustness could be enhanced by systematically analysing the consequences and, as necessary, changing the logic to ensure safety is carefully considered and maximised (page 30).	**83**

3.2.13 Mobile Devices

Mobile Devices The provision of mobile pumps, power supplies and air compressors with prepared quick connections, procedures, and staff training with drills.		**Activity Action No.**
3.2.13.1	Recommendations from National Stress test Report	
3.2.13.1.1	**NPP Dukovany:** Ensuring additional supply source for systems SPS I. category and selected consumer appliances SPS II. category (tab.16)	**18, 38**
3.2.13.1.2	**NPP Dukovany:** Ensuring additional sources for water supply including corresponding procedures and guidelines and availability of trained and qualified personnel (tab.16)	**38**
3.2.13.1.3	**NPP Dukovany:** Ensuring alternative source of electricity for shelters and telephone exchanges (tab.16)	**34**
3.2.13.1.4	**NPP Dukovany:** Ensuring alternative source of electricity for the TSPP supply (tab.16)	**34**
3.2.13.1.5	**NPP Temelin:** Alternative supply of diesel fuel from a tank truck for long-term operation of the DG (tab.34)	**22**
3.2.13.1.6	**NPP Temelin:** Alternative water supply for SG/SFSP/I.C (in case of I.C leakage) including corresponding procedures and guidelines and availability of trained and qualified personnel (tab.34)	**16, 36, 41**
3.2.13.1.7	**NPP Temelin:** Alternative source for recharging accumulator batteries and supplying selected appliances (tab.34)	**21**
3.2.13.2	Recommendations from ENSREG Country Peer Review	
3.2.13.2.1	**For both NPPs:** In particular, the following measures have to be implemented: providing mobile (portable) equipment for ensuring feasibility of the SAM actions (page 25.)	**38, 39**
3.2.13.2.2	**For both NPPs:** • increase robustness of storage building structures for mobile devices including fire trucks, or relocation of equipment (page 25.)	**1, 2, 3**

3.2.13.3	Luxembourg general peer review report	
3.2.13.3.1	That the design for storage of mobile equipment to perform necessary safety functions should take account of external events at the design and beyond design levels, to ensure appropriate availability in the event of being required following a significant external event. Similar considerations apply for external hazards robustness of on-site centres for SAM. (§ 5.3.9)	**1, 2, 3**
3.2.13.3.2	Availability of a variety of mobile devices, with prepared quick connections, procedures on how to connect and use and staff training for deployment of such equipment. It is important that the equipment is to be stored in locations that are safe and secure even in the event of general devastation caused by events (significantly) beyond the design basis. Mobile sources of power would enable the use of existing equipment; mobile pumps would enable direct feeding of the primary or secondary side, even using alternative sources of water. Mobile battery chargers or mobile DC power sources will allow extended use of instrumentation and operation of controls. Fire-fighting equipment, including fire trucks, diesel pumps, generators, emergency lighting, etc., is normally readily available at the plants. Engineered and prepared connections as well as drills on the use of this equipment significantly add to the robustness for BDB events. (§6.3.1)	**13, 14, 38, 39, 42, 43**

3.2.14 Bunkered/Hardened Systems

Bunkered/Hardened Systems The provision for a bunkered or "hardened" system to provide an additional level of protection with trained staff and procedures designed to cope with a wide variety of extreme events including those beyond the design basis (this also applies to Topic 3 recommendations).		**Activity Action No.**
3.2.14.1	Recommendations from National Stress test Report	
3.2.14.1.1	**NPP Dukovany:** Alternative means of communications after a seismic event (tab.10)	**57**
3.2.14.1.2	**NPP Dukovany:** Analysis regarding threat to shelters in the case of floods (tab.11)	**9**
3.2.14.1.3	**NPP Temelin:** Analysis of the threat to the shelters in case of a seismic event (tab.30)	**45,**
3.2.14.1.4	**NPP Temelin:** Analysis of the threat to the shelters in case of floods (tab.31)	**9, 60**
3.2.14.2	Recommendations from ENSREG Country Peer Review	

3.2.14.2.1	**For both NPP:** Some modifications to emergency procedures and analyses regarding the usability of the shelters under flooding conditions are foreseen. (page 10)	**9, 60**
3.2.14.2.2	**NPP Temelin:** Increasing the protection of the diesel fuel pumps against the effects of flooding and also an alternative shelter is to be set up for the emergency response organization when the dedicated emergency response centre is damaged due to some external hazard. (page 10)	**9**
3.2.14.3	Luxembourg general peer review report	
3.2.14.3.1	That some countries have proposed to develop a “hardened core” of selected safety systems protected against extreme hazards. (§ 5.3.8)	**1, 2, 3, 8, 9, 15, 16, 17, 18, 19, 20, 21**
3.2.14.3.2	Within the stress tests evaluation the bunkered system proved its worth in ensuring an additional level of protection, able to cope with a variety of initiators, including those beyond the design basis. The concept is taken even further in the form of the "hardened core" where in addition to equipment, trained staff and procedures designed to cope with a wide variety of extreme events will be available. (§ 6.3.4)	**15, 16, 17, 18, 19**

3.2.15 Multiple Accidents

Multiple Accidents The enhancement of the capability for addressing accidents occurring simultaneously on all plants of the site and consideration of the site as a whole for a multi-units site in the safety assessment.		**Activity Action No.**
3.2.15.1	Recommendations from National Stress test Report	
3.2.15.1.1	**NPP Dukovany:** Ensuring of sufficient amount of staff after a seismic event (tab.10)	**40, 41**
3.2.15.1.2	**NPP Dukovany:** Ensuring sufficient personnel during long-term SBO (tab.16)	**40, 41**
3.2.15.1.3	**NPP Dukovany:** Preparation of the procedure for the loss of UHS and ESW systems on all 4 units (tab.17)	**53**

3.2.15.1.4	**NPP Dukovany:** Extending existing procedures with the procedure for filling SG of all four units by fire extinguishing technology (tab.17)	**13**
3.2.15.1.5	**NPP Dukovany:** Ensuring staffing of CR (tab.21)	**37**
3.2.15.1.6	**NPP Temelin:** Security of the staff after a seismic event (tab.30)	**52, 60**
3.2.15.1.7	**NPP Temelin:** Access to buildings, accessibility for heavy machinery (tab.30)	**53, 60**
3.2.15.1.8	**NPP Temelin:** Ensuring safety and operational staff in case of extreme events (tab.33)	**36, 37, 40, 41**
3.2.15.1.9	**NPP Temelin:** Procedure for restoring the power supply after an SBO in all units (tab.34)	**18, 19**
3.2.15.1.10	**NPP Temelin:** Analyses of the possibility of shift staff in case of an SBO in both units (tab.34)	**36, 37**
3.2.15.2	Recommendations from ENSREG Country Peer Review	
3.2.15.2.1	**NPP Dukovany:** Develop a procedure for the loss of UHS and ESW systems in all 4 units (page 17.)	**53**
3.2.15.2.2	**NPP Temelin:** As it has been already mentioned, nearly all severe accident management measures are dependent on AC power by relying on battery back-up power, local manual operations, diesel generators, pumps, etc. If the power supply in both Units is lost, the shift personnel could also be overloaded by activities related to restoring the power supply. This means that the capacity of the personnel on-site would not be sufficient to cope with the multi-Unit accidents. Further measures are foreseen. (page 23.)	**36, 37, 40, 41**
3.2.15.2.3	**NPP Temelin:** Develop a procedure for the loss of UHS and ESW systems in both units (page 17.)	**53**
3.2.15.2.4	**For both NPPs:** In particular, the following measures have to be implemented: further analyses of the impacts from the infrastructure damages, multiple Unit accidents etc on the SAM and emergency response provisions. (page 25)	**44, 51**
3.2.15.3	Luxembourg general peer review report	

3.2.15.3.1	The stress tests evaluation identified issues and consequently led to improvements in preparedness for the events that could affect multiple units. Previously, the multi-unit site protections were sometimes designed to cope with a serious challenge facing one of the units. During the stress tests, it was identified that robustness could be enhanced if additional equipment and trained staff were to be made available to deal with events affecting all the units on one site. While the process of improvement is not yet completed, it has been initiated on many sites. (§ 6.3.5)	**38, 39, 40, 41, 42, 43**

3.2.16 Equipment Inspection and Training Programs

	Equipment Inspection and Training Programs The establishment of regular programs for inspections to ensure that a variety of additional equipment and mobile devices are properly installed and maintained, particularly for temporary and mobile equipment and tools used for mitigation of BDB external events. Development of relevant staff training programmes for deployment of such devices.	**Activity Action No.**
3.2.16.1	Recommendations from National Stress test Report	
3.2.16.1.1	**NPP Dukovany:** Introduction of TSC training in the area of severe accidents (tab.21)	**55**
3.2.16.1.2	**NPP Temelin:** Verification of the system functions in beyond design basis operating states (tab.36)	**51**
3.2.16.2	Recommendations from ENSREG Country Peer Review	
3.2.16.2.1	**NPP Dukovany:** In the area of abilities to manage severe accidents opportunities were identified to increase the safety. This concerns administrative solutions, personnel area as well as hardware. The key proposed measures include: • enhancement of the staff training in SAM field (page 23.)	**55, 56**
3.2.16.2.2	**NPP Temelin:** To manage severe accidents there are still opportunities to increase the safety. This concerns administrative solutions, personnel area as well as hardware. The key proposed measures by the regulatory authority include: • enhancement of the staff training in SAM field (page 23.)	**55**
3.2.16.2.3	**For both NPPs:** • Implement system for periodic verification of operability of new mobile equipment • Implement system for training of new mobile equipment usage	**42, 43**

3.2.17 Further Studies to Address Uncertainties

Further Studies to Address Uncertainties The performances of further studies in areas were there are uncertainties. Uncertainties may exist in the following areas: · The integrity of the SFP and its liner in the event of boiling or external impact. · The functionality of control equipment (feedwater control valves and SG relief valves, main steam safety valves, isolation condenser flow path, containment isolation valves as well as depressurisation valves) during the SBO to ensure that cooling using natural circulation would not be interrupted in a SBO. · The performance of additional studies to assess operation in the event of widespread damage, for example, the need different equipment (e.g. bulldozers) to clear the route to the most critical locations or equipment. This includes the logistics of the external support and related arrangements (storage of equipment, use of national defence resources, etc.).		**Activity Action No.**
3.2.17.1	Recommendations from National Stress test Report	
3.2.17.1.1	**NPP Dukovany:** Analyses: Seismic resistance of LFRU building (tab.10)	**2**
3.2.17.1.2	**NPP Dukovany:** Analyses: Seismic PSA (tab.10)	**4, 70**
3.2.17.1.3	**NPP Dukovany:** Analyses: Analysis regarding threat to shelters in the case of floods (tab.11)	**9, 50**
3.2.17.1.4	**NPP Dukovany:** Analyses: Resistance of civil structures (LFRU, CPS, MPU, etc.) to extreme conditions (tab.15)	**1, 2**
3.2.17.1.5	**NPP Dukovany:** Analyses: To work out methods of evaluation of external effects, verification of analyses performed, possible technical measures (tab.15)	**12**
3.2.17.1.6	**NPP Dukovany:** Analyses: Analysis of the discharging time of accumulator batteries for the unit for releasing the load, revize OIs , changing the connection and operation of emergency lighting (tab.16)	**75**
3.2.17.1.7	**NPP Dukovany:** Analyses: The collection of cooling from SFSP by adding coolant and accumulation in TH tanks (tab.17)	**15**
3.2.17.1.8	**NPP Temelin:** Analyses: Resilience of the LFRU (local fire rescue unit) to seismicity (tab.30)	**3**

3.2.17.1.9	**NPP Temelin:** Analyses: Access to buildings, accessibility for heavy machinery (tab.30)	**53, 60**
3.2.17.1.10	**NPP Temelin:** Analyses: Analysis of the threat to the shelters in case of floods (tab.31)	**9, 60**
3.2.17.1.11	**NPP Temelin:** Analyses: Elaborating methodology for assessing external effects, verification of analyses carried out, possible technical measures (tab.33)	**12, 44, 52**
3.2.17.1.12	**NPP Temelin:** Analyses: Analysis of heat removal from I&C after losing the ESW (tab.34)	**26**
3.2.17.1.13	**NPP Temelin:** Analyses: Analysis of the discharging period of the accumulator batteries in case of a controlled reduction of the load, revision of procedures (tab.34)	**75**
3.2.17.1.14	**NPP Temelin:** Analyses: Transfer of heat from the SFSP without an additional water supply (tab.34)	**81**
3.2.17.1.15	**NPP Temelin:** Analyses: Analyses of the possibility of shift staff in case of an SBO in both units (tab.34)	**36, 41**
3.2.17.1.16	**NPP Temelin:** Analyses: Localization of melt outside the RPV (tab.36)	**49**
3.2.17.1.17	**NPP Temelin:** Analyses: Analysis of the radiation situation in the CR/ ECR in case of a severe accident (tab.36)	**58**
3.2.17.1.18	**NPP Temelin:** Analyses: Analyse the possibility and various alternatives of modifications to complete the original containment design with the feasible venting option for the case of severe accidents (Type II). (page 299.)	**49**
3.2.17.2	Recommendations from ENSREG Country Peer Review	
3.2.17.2.1	**For both NPPs:** In particular, the following measures have to be implemented: Further analyses of the impacts from the infrastructure damages, multiple Unit accidents etc on the SAM and emergency response provisions. (page 25.)	**44, 51, 61**

3.3 Topic 3 - Severe accident management

Severe accident management

The objectives of managing (control) accidents in both NPPs are to ensure the 4th level of defence-in-depth protection (to limit consequences after the origination of an accident). This level is followed by the 5th level of defence-in-depth related to the emergency preparedness of the NPP as the (mitigate consequences of accidents with releases of Ra substances). Both NPPs have implemented a system for managing accidents for ensuring the 4th level of defence-in-depth protection and the system of emergency preparedness for ensuring the 5th level of defence-in-depth protection. The functioning of the mutually linked systems for managing accidents and accident preparedness is ensured by the comprehensive set of measures of personnel, administrative and technical character.

Hydrogen mitigation in containment

Containments of NPP Dukovany units are fitted with a system for liquidating post accident hydrogen which is solely designed for design basis accidents. For the LOCA accidents, where only a very low volume of hydrogen is produced, there are 17 hydrogen recombiners available in the containment. Enhancement of the robustness of the NPP Dukovany for severe accidents was decided after the Periodic Safety Review in 2006. In the final phase of the preparation, there is a project for the construction of the system for effective liquidation of hydrogen which will be able to manage hypothetically originated hydrogen in the case of the worst scenario (in terms of the production of hydrogen) of a severe accident. The current analyses and experience from other VVER confirmed that such a system consisting of powerful re-combiners (approx 30 pieces) completed with burners in the case of functioning spray system, can restrict the risk of the flame spreading and exclude the risk of the detonation. (National report, page 146)

The containments in the Temelín NPP are equipped with a post-accident hydrogen liquidation system, designed for design basis accidents. This system contains passive autocatalytic recombiners and it is able to dispose hydrogen released during accidents for a long period of time, thus keeping the concentration of hydrogen low enough to prevent its combustion – but only during design basis accidents. The existing hydrogen management system might not be sufficient for severe accidents. However, a project is currently being prepared that involves the installation of a hydrogen management system to liquidate hydrogen produced during severe accidents. (National report, page 275)

At the end of 2017, all actions related to the above mentioned issues were completed.

Containment overpressure

The purpose of the design function of the containment in NPP Dukovany is to prevent the release of Ra substances into the environment, or to restrict the radiation consequences of the accident in the surroundings. The containment represents the last barrier against release and is independent of the other barriers. The function of the containment is ensured by the construction and the structure which definitely resists design over-pressure of 150 kPa and with most probability, double over-pressure. The tightness of the containment is regularly inspected (within the PERIZ tightness test) and measures are taken to maintain or to increase the tightness. (National report, page 146)

The integrity of the containments within the Temelín NPP is ensured by the following systems:
- Containment isolation system – separating valves automatically closed when the pressure in the containment increases. Operability depends on power supply.
- System for pressure reduction in the containment – spray pumps and supply tanks with chemical reagents capturing post-accident iodine. The operability depends on the power supply.
- Post-accident hydrogen management system – passive auto-catalytic recombiners, designed for design basis accidents – does not require a power supply. (National report, page 276)

3.3 Topic 3 - Severe accident management

3.3.1 WENRA Reference Levels

No.	Recommendations	Activity Action No.
WENRA Reference Levels The incorporation of the WENRA reference levels related to severe accident management (SAM) into their national legal frameworks, and ensure their implementation in the installations as soon as possible.		
3.3.1.1	Luxembourg general peer review report	
3.3.1.1.1	In response to their previous commitments, regulators should incorporate the WENRA reference levels related to SAM into their national legal frameworks, and ensure then implementation as soon as possible. (§ 7.3.2)	**62**

3.3.2 SAM Hardware Provisions

No.	Recommendations	Activity Action No.
SAM Hardware Provisions Adequate hardware provisions that will survive external hazards (e.g. by means of qualification against extreme external hazards, storage in a safe location) and the severe accident environment (e.g. engineering substantiation and/or qualification against high pressures, temperatures, radiation levels, etc), in place, to perform the selected strategies.		
3.3.2.1	Recommendations from National Stress test Report	
3.3.2.1.1	**NPP Dukovany:** Increase of the capacity of the system for the liquidation of emergency hydrogen (tab.22)	**46**
3.3.2.1.2	**NPP Dukovany:** Cooling of the melt from the outside of RPV (tab.22)	**48**
3.3.2.1.3	**NPP Dukovany:** Oxygen regeneration in shelters (tab.21)	**60**
3.3.2.1.4	**NPP Temelin:** Alternative supply of water into the containment reservoir (tab.36)	**16**

3.3.2.1.5	**NPP Temelin:** System for the liquidation of hydrogen in the containment in case of a severe accident (tab.36)	**47**
3.3.2.2	Recommendations from ENSREG Country Peer Review	
3.3.2.2.1	**For both NPPs:** • Re-criticality The normal procedure is to feed borated water into the reactor coolant system. For some circumstances the SAMGs at both sites (Temelin and Dukovany) include the strategies allowing injection of non-borated water into the reactor as a last possibility to cool the fuel or debris at in-vessel phase of severe accident progression. As it has been clarified during the country visit the possibility of re-criticality has been considered by the NPPs and has been excluded based on certain qualitative considerations, although no dedicated detailed analyses have been performed. It is recommended that regulatory authority considers the need of requesting additional investigations of the potential for re-criticality for the correspondent SAM strategies. (page 21.)	**61**
3.3.2.2.2	**For both NPPs:** • Control rooms: The main control rooms (MCR) and the emergency control rooms (ECR) are equipped with emergency filtered ventilation systems and are shielded and protected sufficiently against radiation. The habitability of the MCR and ECR in case of containment failure during a severe accident has not been analysed. Finally, it is recognized that not all systems used under SAM are designed to withstand earthquakes. It is recommended that the seismic resistance of the systems used for severe accident management should be further analysed. (page 21.)	**58, 31, 51**

3.3.2.2.3	**For both NPPs:** In particular, the following measures have to be implemented: • alternative containment sump water make up (Temelin) • selection and implementation of appropriate solution for protecting containment from the overpressure loads; • providing mobile (portable) equipment for ensuring feasibility of the SAM actions; • ex-vessel cooling at Dukovany NPP • cooling of molten core is still an open issue for Temelin NPP • installation of additional recombiners sufficient for severe accident conditions at Temelin and Dukovany NPPs A filtered venting system to protect the containment against loss of integrity and to reduce significantly the releases of radioactivity to the environment should be analysed in order to determine any appropriate modifications for all units at Temelin NPP and for all units at Dukovany NPP. The current system is not designed for severe accident conditions. The filtered venting system would limit a long-term containment over pressurization resulting from accumulation of non-condensable gases and decay heat, generated inside the containment in case of a severe accident. Implementation of the measures identified during stress tests and recommended during peer review of the national report will ensure robustness of the SAM arrangements of the Dukovany and Temelin NPPs. (page 25.)	**15, 16, 46, 47, 48, 49, 50**
3.3.2.3	Luxembourg general peer review report	
3.3.2.3.1	Effective implementation of SAM requires that adequate hardware provisions are in place to perform the selected strategies. (§ 7.3.3)	**51**
3.3.2.3.2	The means for maintaining containment integrity should in particular include depressurization of the reactor coolant system, prevention of damaging hydrogen explosions, and means of addressing long-term containment over-pressurization, such as filtered venting. (§ 7.3.4)	**46 – 50**
3.3.2.4	ENSREG -Follow-up fact finding site visit NPP Temelin	
3.3.2.4.1	Selection of appropriate strategy to protect containment against overpressure (filtered venting system is one option) (page 4.)	**49**
3.3.2.4.2	Installation of additional sufficient hydrogen recombiners for severe accident conditions (page 4.)	**47**
3.3.2.4.3	Instrumentation for SA harsh conditions (Analysis and measures) (page 4.)	**51**
3.3.2.4.4	Corium in/ex vessel cooling (page 4.)	**48, 49, 50**
3.3.2.5	Final Summary Report of the 2nd Extraordinary Meeting of the Contracting Parties to the CNS	

3.3.2.5.1	Upgrading safety systems or installing additional equipment and instrumentation to enhance the ability of each nuclear power plant to withstand an unexpected natural event without access to the electrical power grid for an extended period of time, including for an external event affecting multiple units. (page 6.)	**13 – 27, 76**

3.3.3 Review of SAM Provisions Following Severe External Events

Review of SAM Provisions Following Severe External Events The systematic review of SAM provisions focusing on the availability and appropriate operation of plant equipment in the relevant circumstances, taking account of accident initiating events, in particular extreme external hazards and the potential harsh working environment.		**Activity Action No.**
3.3.3.1	Recommendations from National Stress test Report	
3.3.3.1.1	**Both NPPs:** Verification of the system functions in beyond design basis operating states (tab.36)	**51**
3.3.3.2	Luxembourg general peer review report	
3.3.3.2.1	PSR should continue to be maintained as a powerful regulatory instrument for the continuous enhancement of defence-in-depth in general, and the provisions of SAM in particular. The lessons learned from the Fukushima accident and from the stress tests should be reflected in the scope of future PSRs. (§ 7.3.1)	**72**
3.3.3.2.2	A systematic review of SAM provisions should be performed, focusing on the availability and appropriate operation of plant equipment in the relevant circumstances, taking account of accident initiating events, in particular extreme external hazards and the potential harsh working environment. (§ 7.3.5)	**51**
3.3.3.2.3	The assessment of SAM provisions should take account of the need to work with a severely damaged infrastructure (i.e. in which the usual means of communication and access, etc. are disabled) of plant level, corporate-level and national-level aspects and of long-duration accidents affecting multiple units at the same time (on individual and nearby sites as appropriate). (§ 7.3.6)	**36, 37, 43, 52, 53, 40, 41, 57, 59, 77**
3.3.3.3	ENSREG -Follow-up fact finding site visit NPP Temelin	
3.3.3.3.1	Further analyses of the impacts from the infrastructure damages, multiple Unit accidents etc on the SAM and emergency response provisions. (page 4.)	**36, 37, 52, 53, 40, 41, 57, 59, 77**

3.3.3.4	Final Summary Report of the 2nd Extraordinary Meeting of the Contracting Parties to the CNS	
3.3.3.4.1	Performing or planning an evaluation of the guidance that is to be used by the operator to manage emergency situations resulting from severe accidents caused by extreme natural phenomena at nuclear power plants, including for low power and shutdown states. These documents include emergency operating procedures to prevent core damage, severe accident management guidelines to prevent containment failure, and extensive damage mitigation guidelines to address accidents that result in fires or explosions that affect a large portion of a nuclear power plant. (page 6.)	**53, 56**

3.3.4 Enhancement of Severe Accident Management Guidelines (SAMG)

Enhancement of Severe Accident Management Guidelines (SAMG) In conjunction with the recommendation 2.4, the enhancement of SAMGs taking into account additional scenarios, including, a significantly damaged infrastructure, including the disruption of plant level, corporate-level and national-level communication, long-duration accidents (several days) and accidents affecting multiple units and nearby industrial facilities at the same time.		**Activity Action No.**
3.3.4.1	Recommendations from National Stress test Report	
3.3.4.1.1	**NPP Dukovany:** Prepare “shutdown SAMG” for shutdown / Severe accident in SFSP (tab.21)	**56**
3.3.4.1.2	**NPP Temelin:** Execute “SAMG shutdown” (fuel degradation with open reactor/in SFSP) (tab.36)	**56**
3.3.4.2	Recommendations from ENSREG Country Peer Review	
3.3.4.2.1	**For both NPPs:** development of SAMGs for shutdown modes including open reactor and SFP accidents; (page 25.)	**56**
3.3.4.3	ENSREG -Follow-up fact finding site visit NPP Temelin	
3.3.4.3.1	Developing extensive damage mitigation guidelines (page 3.)	**53**
3.3.4.3.2	Development of SAMGs for shutdown modes including open reactor, SFP accidents and multi unit accidents (page 4.)	**56**
3.3.4.4	Analysis of human resources, communication, personnel training and guidance during severe long term accidents (esp. multi-unit) and validation of effectiveness through exercises	**36, 37, 40, 41, 43, 54, 55, 57**

3.3.5 SAMG Validation

SAMG Validation The validation of the enhanced SAMGs.		**Activity Action No.**
3.3.5.1	Luxembourg general peer review report	
3.3.5.1.1	The SAMGs should be comprehensively validated taking due account of the potential long duration of the accident, the degraded plant and the surrounding conditions. Pre-planned SAM actions should be designed to function effectively and robustly for suitably lengthy periods following the initiating event. In most cases, durations of at least several days should be assumed for planning and assessment purposes. (§ 7.3.7)	**54**
3.3.5.2	Final Summary Report of the 2nd Extraordinary Meeting of the Contracting Parties to the CNS	
3.3.5.2.1	Developing probabilistic safety assessments to identify additional accident management measures or changes in radiation protection measures for workers on the site that might be needed to perform necessary activities in the event of a severe accident. (page 6.)	**69**

3.3.6 SAM Exercises

SAM Exercises Exercises aimed at checking the adequacy of SAM procedures and organisational measures, including extended aspects such as the need for corporate and nation level coordinated arrangements and long-duration events.		**Activity Action No.**
3.3.6.1	Final Summary Report of the 2nd Extraordinary Meeting of the Contracting Parties to the CNS	
3.3.6.1.1	Reviewing and updating national, regional, provincial, municipal and local emergency plans and conducting exercises to encourage greater coordination among the different organizations. (page 6.)	**55, 66**

3.3.7 SAM Training

SAM Training Regular and realistic SAM training exercises aimed at training staff. Training exercises should include the use of equipment and the consideration of multi-unit accidents and long-duration events. The use of the existing NPP simulators is considered as being a useful tool but needs to be enhanced to cover all possible accident scenarios.		**Activity Action No.**
3.3.7.1	Recommendations from National Stress test Report	

3.3.7.1.1	**NPP Dukovany:** Introduction of TSC training in the area of severe accidents (tab.21)	**55**
3.3.7.1.2	**NPP Temelin:** Appointing qualified and well-trained staff to the ERO (tab.36)	**55**
3.3.7.2	Recommendations from ENSREG Country Peer Review	
3.3.7.2.1	**NPP Dukovany:** The key proposed measures include: enhancement of the staff training in SAM field (page 23.)	**55**
3.3.7.2.2	**NPP Temelin:** To manage severe accidents there are still opportunities to increase the safety. This concerns administrative solutions, personnel area as well as hardware. The key proposed measures by the regulatory authority include: • enhancement of the staff training in SAM field (page 23.)	**55**
3.3.7.3	Luxembourg general peer review report	
3.3.7.3.1	Training and exercises aimed at checking the adequacy of SAM procedures and organisational measures should include testing of extended aspects such as the need for corporate and national level coordinated arrangements and long-duration events (§ 7.3.8)	**55**

3.3.8 Extension of SAMGs to All Plant States

Extension of SAMGs to All Plant States The extension of existing SAMGs to all plant states (full and low-power, shutdown), including accidents initiated in SFPs.		**Activity Action No.**
3.3.8.1	Recommendations from National Stress test Report	
3.3.8.1.1	**NPP Dukovany:** Prepare “shutdown SAMG” for shutdown / Severe accident in SFSP (tab.21)	**56**
3.3.8.1.2	**NPP Dukovany:** EDMG manuals for the use of alternative means (tab.21)	**53**
3.3.8.1.3	**NPP Temelin:** Execute “SAMG shutdown” (fuel degradation with open reactor/in SFSP) (tab.36)	**56**
3.3.8.1.4	**NPP Temelin:** EDMG manuals for the use of alternative means (tab.36)	**53**

3.3.8.2	Recommendations from ENSREG Country Peer Review	
3.3.8.2.1	**NPP Dukovany:** In the area of abilities to manage severe accidents opportunities were identified to increase the safety. This concerns administrative solutions, personnel area as well as hardware. The key proposed measures include: • improvement of the crisis plans and SAM documentation (e.g., providing SAMG for shutdown states and spent fuel pool accidents) (page 23.)	**56, 66**
3.3.8.2.2	**NPP Temelin:** To manage severe accidents there are still opportunities to increase the safety. This concerns administrative solutions, personnel area as well as hardware. The key proposed measures by the regulatory authority include: • improvement of the crisis plans and SAM documentation (e.g., providing SAMG for shutdown states and spent fuel pool accidents) (page 23.)	**56, 66**
3.3.8.2.3	**For both NPPs:** As a result of the stress tests several measures to increase the safety level of the NPPs were identified and will be analysed and implemented in the future. Although the exact list of actions, priorities and schedule of implementation of these measures are still being finalized by the licensee and the regulatory authority, some of them have been clearly specified in the national report. In particular, the following measures have to be implemented: • development of SAMGs for shutdown modes including open reactor and SFP accidents (page 25.)	**56**
3.3.8.2.4	**For both NPPs:** Accidents during shutdown states and occurring at the SFP are not addressed in the existing SAMGs, but will be available by 2014. It is recommended that SUJB considers how to monitor the implementation. (page 26.)	**56**

3.3.9 Improved Communications

Improved Communications The improvement of communication systems, both internal and external, including transfer of severe accident related plant parameters and radiological data to all emergency and technical support centre and regulatory premises.		**Activity Action No.**
3.3.9.1	Recommendations from National Stress test Report	
3.3.9.1.1	**NPP Dukovany:** Alternative means of communications after a seismic event (tab.10)	**57**

3.3.9.1.2	**NPP Dukovany:** Ensuring alternative means for warning and notification of NPP Dukovany personnel and inhabitants in EPZ (tab.21)	**57**
3.3.9.1.3	**NPP Dukovany:** Ensuring alternative source of electricity for safe places and telephone exchanges (tab.16)	**34**
3.3.9.1.4	**NPP Temelin:** Alternative means of communication after a seismic event (tab.30)	**57**
3.3.9.1.5	**NPP Temelin:** Alternative sources and means of communication after a seismic event (tab.34)	**35**
3.3.9.2	Recommendations from ENSREG Country Peer Review	
3.3.9.2.1	**NPP Dukovany:** In the area of abilities to manage severe accidents opportunities were identified to increase the safety. This concerns administrative solutions, personnel area as well as hardware. The key proposed measures include: additional technical measures (ensuring access to facilities, alternative communication means, etc). (page 23.)	**57**
3.3.9.2.2	**NPP Temelin:** To manage severe accidents there are still opportunities to increase the safety. This concerns administrative solutions, personnel area as well as hardware. The key proposed measures by the regulatory authority include: • additional technical measures (ensuring access to facilities, alternative communication means, etc). (page 23.)	**57, 59, 60**
3.3.9.3	ENSREG -Follow-up fact finding site visit NPP Temelin	
3.3.9.3.1	Emergency response provisions such as providing long term communication, alternative means (cell phones, radios, limited wire telephone) etc. (page 3.)	**57**
3.3.9.4	Final Summary Report of the 2nd Extraordinary Meeting of the Contracting Parties to the CNS	
3.3.9.4.1	Improving their radiation monitoring and communications capabilities and enhancing public communications, such as via dedicated public websites. (page 6.)	**63**

3.3.10 Presence of Hydrogen in Unexpected Places

Presence of Hydrogen in Unexpected Places The preparation for the potential for migration of hydrogen, with adequate countermeasures, into spaces beyond where it is produced in the primary containment, as well as hydrogen production in SFPs.		**Activity Action No.**
3.3.10.1	Recommendations from National Stress test Report	
3.3.10.1.1	**NPP Dukovany:** Increase of the capacity of the system for the liquidation of emergency hydrogen (tab.22)	**61**
3.3.10.1.2	**NPP Dukovany:** Prepare “shutdown SAMG” for shutdown / Severe accident in SFSP (tab.22)	**56**
3.3.10.1.3	**NPP Temelin:** System for the liquidation of hydrogen in the containment in case of a severe accident (tab.36)	**47, 61**
3.3.10.2	Recommendations from ENSREG Country Peer Review	
3.3.10.2.1	**For both NPPs:** installation of additional recombiners sufficient for severe accident conditions at Temelin and Dukovany NPPs (page 25.)	**46, 47**

3.3.11 Large Volumes of Contaminated Water

Large Volumes of Contaminated Water The conceptual preparations of solutions for post-accident contamination and the treatment of potentially large volumes of contaminated water.		**Activity Action No.**
3.3.11.1	Luxembourg general peer review report	
3.3.11.1.1	When developing SAM action plans, conceptual solutions for post-accident fixing of contamination and the treatment of potentially large volumes of contaminated water should be addressed. (§ 7.3.9)	**68**

3.3.12 Radiation Protection

Radiation Protection The provision for radiation protection of operators and all other staff involved in the SAM and emergency arrangements.		**Activity Action No.**
3.3.12.1	Recommendations from National Stress test Report	

3.3.12.1.1	**NPP Dukovany:** Completion of measurements of the Ra situation and the status of SFSP (tab.21)	**27, 32**
3.3.12.1.2	**NPP Temelin:** Analysis of the radiation situation in the CR/ ECR in case of a severe accident (tab.36)	**58**
3.3.12.1.3	**NPP Temelin:** Connecting isolation valves of the containment ventilation system to the accumulator batteries (tab.34)	**82**
3.3.12.2	Recommendations from ENSREG Country Peer Review	
3.3.12.2.1	**For both NPPs:** The main control rooms (MCR) and the emergency control rooms (ECR) are equipped with emergency filtered ventilation systems and are shielded and protected sufficiently against radiation. The habitability of the MCR and ECR in case of containment failure during a severe accident has not been analysed. Finally, it is recognized that not all systems used under SAM are designed to withstand earthquakes. It is recommended that the seismic resistance of the systems used for severe accident management should be further analysed (page 21.)	**58**
3.3.12.3	Luxembourg general peer review report	
3.3.12.3.1	Radiation protection of operators and all other staff involved in the SAM and emergency arrangements should be assessed and then ensured by adequate monitoring, guaranteed habitability of the facilities (hardened on-site emergency response facility with radiation protection) needed for accident control, and suitable availability of protective equipment and training. (§ 7.3.10)	**58, 59, 60**

3.3.13 On Site Emergency Centre

On Site Emergency Centre The provision of an on-site emergency centre protected against severe natural hazards and radioactive releases, allowing operators to stay onsite to manage a severe accident.		**Activity Action No.**
3.3.13.1	Recommendations from National Stress test Report	
3.3.13.1.1	**NPP Dukovany:** To ensure working of emergency response units in case of unavailability of ECC (tab.10)	**59**
3.3.13.1.2	**NPP Dukovany:** Ensuring the functioning of emergency response elements in the case of non-accessibility of ECC (tab.16)	**59**

3.3.13.1.3	**NPP Temelin:** OER (organization of emergency response) ability outside the ECC (emergency control centre) (tab.30)	**59**
3.3.13.1.4	**NPP Temelin:** Ability of the OER to function via the ECC (tab.31)	**59**
3.3.13.1.5	**NPP Temelin:** Ability of the ERO to function outside the ECC (tab.36)	**59**
3.3.13.2	Recommendations from ENSREG Country Peer Review	
3.3.13.2.1	**For both NPPs:** Control rooms: The main control rooms (MCR) and the emergency control rooms (ECR) are equipped with emergency filtered ventilation systems and are shielded and protected sufficiently against radiation. The habitability of the MCR and ECR in case of containment failure during a severe accident has not been analysed. Finally, it is recognized that not all systems used under SAM are designed to withstand earthquakes. It is recommended that the seismic resistance of the systems used for severe accident management should be further analysed. (page 21.)	**58**
3.3.13.3	Final Summary Report of the 2nd Extraordinary Meeting of the Contracting Parties to the CNS	
3.3.13.3.1	Upgrading regional, off-site and on-site emergency response centres. (page 6.)	**59**

3.3.14 Support to Local Operators

Support to Local Operators Rescue teams and adequate equipment to be quickly brought on site in order to provide support to local operators in case of a severe situation.		**Activity Action No.**
3.3.14.1	Recommendations from National Stress test Report	
3.3.14.1.1	**NPP Dukovany:** Preparation of agreements with external elements (IRS, army) and nearby NPP. Organizational measures (tab.21)	**37**
3.3.14.1.2	**NPP Temelin:** Prepare agreements with external organisations (IRS, army) close to the NPP. Organizational measures (tab.36)	**36**
3.3.14.1.3	To consider the establishment of a common VVER operator centre for mutual aid in the case of severe accidents (Dukovany, Bohunice, Mochovce, Paks) (page 299.) Note:	**No action (see Note)**

	Establishment of VVER operators centre was not found feasible. Each operator is preparing necessary resources without cooperation with others.	
3.3.14.2	Recommendations from ENSREG Country Peer Review	
3.3.14.2.1	**NPP Dukovany:** In the area of abilities to manage severe accidents opportunities were identified to increase the safety. This concerns administrative solutions, personnel area as well as hardware. The key proposed measures include: completion of off-site places for their use as alternative location for SAM team (page 23.)	**59**

3.3.15 Level 2 Probabilistic Safety Assessments (PSAs)

Level 2 Probabilistic Safety Assessments (PSAs) A comprehensive Level 2 PSA as a tool for the identification of plant vulnerabilities, quantification of potential releases, determination of candidate high-level actions and their effects and prioritizing the order of proposed safety improvements. Although PSA is an essential tool for screening and prioritising improvements and for assessing the completeness of SAM implementation, low numerical risk estimates should not be used as the basis for excluding scenarios from consideration of SAM especially if the consequences are very high.		**Activity Action No.**
3.3.15.1	Recommendations from National Stress test Report	
3.3.15.1.1	**NPP Dukovany:** Seismic PSA (page 79.)	**70**
3.3.15.2	Luxembourg general peer review report	
3.3.15.2.1	Although PSA is an essential tool for screening and prioritising improvements and for assessing the completeness of SAM implementation, low numerical risk estimates should not be used as the basis for excluding scenarios from consideration of SAM especially if the consequences are very high. (§ 7.3.11)	**69, 70**

3.3.16 Severe Accident Studies

Severe Accident Studies The performance of further studies to improve SAMGs.		**Activity Action No.**
3.3.16.1	The availability of safety functions required for SAM under different circumstances.	**51, 61**

3.3.16.2	Accident timing, including core melt, reactor pressure vessel (RPV) failure, basement melt-through, SFP fuel uncover, etc.	**44, 61**
3.3.16.3	PSA analysis, including all plant states and external events for PSA levels 1 and 2.	**69, 70**
3.3.16.4	Radiological conditions on the site and associated provisions necessary to ensure MCR and ECR habitability as well as the feasibility of AM measures in severe accident conditions, multi-unit accidents, containment venting, etc.	**44, 58, 61**
3.3.16.5	Core cooling modes prior to RPV failure and of re-criticality issues for partly damaged cores, with un-borated water supply.	**44, 61**
3.3.16.6	Phenomena associated with cavity flooding and related steam explosion risks.	**44, 61**
3.3.16.7	Engineered solutions regarding molten corium cooling and prevention of basemat melt-through.	**49, 67**
3.3.16.8	Severe accident simulators appropriate for NPP staff training.	**55**
3.3.16.9	xCNS: Filtration efficiency; R&D related to: - In vessel corium retention - Hydrogen risk studies (e.g. large scale test…)	**48, 49, 67**

PART II

4. Issues from CNS EOM Group discussions

4.1 Topic 4 - National organisations

No.	Recommendations	Activity Action No.
4.1.1	Review and revision of nuclear Laws, Regulations and Guides. • Where the RB is constituted of more than one entity, it is important to ensure efficient coordination. • Emphasis on the need for comprehensive periodic reviews of safety, using state-of-the-art techniques. • To remind CP that national safety frameworks include the RB, TSO and Operating Organisations. - Wide participation in safety networks for operating organizations, RB and TSOs will strengthen them	62
4.1.2	Changes to functions and responsibilities of the RB. • Effective independence of the RB is essential, including the following aspects: - Transparency in communicating its regulatory decisions to the public. - Competent and sufficient human resources. - Adequate legal powers (e.g. suspend operation). - Financial resources	62
4.1.3	Importance of inviting IRRS missions, and to: • Effectively implement the findings • Make the findings and their means of resolution publicly available. • Invite follow -up missions.	71

4.1.4	Review and improvements to aspects of National EP&R • How to routinely exercise: - All involved organizations, up to ministerial level - Scenarios based on events at multi-unit sites • How to train intervention personal for potentially severe Accident conditions • Rapid intervention team to provide support to sites • Determination of the size of the EPZ is variable • Trans- border arrangements need to be further considered and exercised • The use of regional centres to provide support to sites • Education of the public and the media in aspects related to emergencies (e.g. radiation does and their effects)	66
4.1.5	Openness, transparency and communication improvements: • Communication with stakeholders is a continuous activity not just in an emergency • Active stakeholder engagement in the decision-making process builds public confidence • International bilateral cooperation can be beneficial (e.g. joint regulatory inspections) • The proper balance of understandable information provided to informed groups and the general public needs to be addressed • The transparency of the operators activities needs to be enhanced	63
4.1.6	Post- Fukushima safety reassessments and action plans: • All CP should perform a safety reassessment and the resolution of their findings should be progressed through a national action plan or other transparent means and should not be limited to NPPs in operation. • Established safety networks should be efficiently used by CP to disseminate and share relevant information.	72
4.1.7	Human and organizational factors (HOF): • There is a need to further develop human resource capacity and competence across all organizations in the field of nuclear safety • Governmental level commitment is needed to ensure along-term approach is developed for capacity building • Collaborative work is needed in the area of improving and assessing HOF, including safety culture. • The role of sub-contractors may be important; can they be hired quickly?	64

4.2 Topic 5 - Emergency Preparedness and Response		
No.	**Recommendations**	**Activity Action No.**
4.2.1	Expansion of the set of scenarios on which the plan was based – NPP PLUS Infrastructure / NPP PLUS chemical plant	66
4.2.2	Increasing the scope of off-site exercise programs to reflect NPP plus external infrastructure simultaneous problems	66
4.2.3	Blending mobile resources into planning and drill programs	42, 43
4.2.4	Increasing emphasis on drilling with neighbouring countries	66
4.2.5	Exercising all interface points (national, regional, municipal,..)	66
4.2.6	Performing of longer term exercises to reflect the challenges of extreme events	66
4.2.7	Enhancing radiation monitoring and communication systems by additional diversification / redundancy	23, 24, 57
4.2.8	Development of a common source term estimation approach	See note at the end of the section 4.2
4.2.9	Provide access to a “big picture” (international picture) of radiological conditions	See note at the end of the section 4.2
4.2.10	Development of reference level for trans-border processing of goods and services such as container transport	See note at the end of the section 4.2
4.2.11	Re-examination of approach and associated limits to govern the “remediation” phase	See note at the end of the section 4.2

4.2.12	Develop criteria for the return to evacuated area and criteria for return to normal from emergency state	See note at the end of the section 4.2
4.2.13	Improvement of the approach to establish contamination monitoring protocols and locations during the recovery phase	See note at the end of the section 4.2
4.2.14	Hardening of support infrastructure (Emergency Response Centres, Sheltering facilities, essential support facilities (like Corporate Offices) with back-up power, environmental radiological filtering, etc.	34, 35
4.2.15	Analyzing medical and human aspects of response to support Emergency workers	See note at the end of the section 4.2
4.2.16	Implementation of processes to enable access to inter-country support including customs processes for access for diplomats and emergency response personal	See note at the end of the section 4.2
4.2.17	Systematic assessment of all aspects of organizations that contribute to emergency response using tools like job and task analysis	See note at the end of the section 4.2
4.2.18	Develop radiological reference levels for rescue and emergency response personnel in extreme events	See note at the end of the section 4.2
4.2.19	Develop reference levels for the application of immediate countermeasures such as sheltering, iodine distribution and evacuation	See note at the end of the section 4.2
	Note: Issues with no specific action are understood as topics where results of international cooperation (research, IAEA, WENRA, and other international organisations) shall be used in the Czech republic when will be available.	

4.3 Topic 6 - International Cooperation

No.	Recommendations	Activity Action No.
4.3.1	Strengthening the peer reviews process of CNS and of missions (IAEA, WANO and Industry) • Effectiveness of IAEA peer review processes should be reviewed in response to concerns raised by the public and Non Governmental Organizations. • The CNS national reports should include how peers review and mission findings have been addressed. • Processes and initiatives should be strengthened to ensure implementation of findings of the peer review and missions. • CNS review meetings should ensure robust peer reviews and reporting of peer review results and findings.	67
4.3.2	Strengthening the peer reviews process of CNS and of missions (IAEA, WANO and Industry) - continue • Plant design safety features and related modifications should be considered in WANO and OSART missions. • Better coordination of WANO and IAEA peer review activities should be established. • International experience gained from the review of Russian designs after Chernobyl could be considered as an example of good international practice.	67
4.3.3	Optimisation of the Global Safety Regime • Primary responsibility for safety remains with operators • The collective responsibility of the various institutions and organizations should be optimized • The growing number of international meetings, assessments, peer reviews and expanding mandates is placing high demands on existing human resources, which may become counter productive • Efforts should be continued to reduce duplication of initiatives and actions by various organizations such as IAEA, NEA, EU, WANO, etc. • The respective roles and objectives of the various organizations, institutions and missions should be recognized in the optimization process	67

4.3.4	Strengthening communication mechanisms through regional and bilateral cooperation • Initiatives relating to the Regional Crisis centre for operators of NPPs with VVER type reactors as being implemented by Moscow WANO Centre and also considered by some other vendor countries. • Bilateral agreements between vendor countries and new embarking countries, complemented by IAEA Standards and review processes, have been reported to be effective and should be encouraged. • Strong support of political leaders is important to establish the necessary nuclear safety infrastructure. • Countries with established nuclear programmes should assist with the establishment of nuclear and regulatory infrastructure. • Countries should cooperate with neighbouring and regional countries and exchange information on their civil nuclear power programmes.	67
4.3.5	Effectiveness of experience feedback mechanisms • Information exchange and feedback should be enhanced by using the established mechanisms (e.g. IRS, INES) and organisations (eg. WANO). • The sharing and utilisation of information is limited and not always necessarily well coordinated or disseminated. This has been identified as an area for improvement. • All nuclear power plants should share Operating Experience. • The current focus is on reporting events and not necessarily on learning from the events. Effectiveness of Operating Experience Feedback should be assessed and its implementation should be included in peer reviews.	67
4.3.6	Strengthening and expanded use of IAEA Safety Standards • The Safety Fundamentals remain appropriate as a sound basis for nuclear safety when properly implemented. • Implementation should strike the right balance between prevention and mitigation. • The IAEA Safety Standards should be taken into account in developing national nuclear safety regulations. • These Safety Standards have a role to play in seeking continuous improvements to safety at existing nuclear power plants.	62

Part III

5. Cross-cutting issues		
No.	**Recommendations**	**Activity Action No.**
5.1 4.4.1	Public discussion of safety issues should be encouraged (Transparency)	63
5.2 4.4.2	An open and trustful relationship between regulators, operators and the public with keeping in mind their respective roles and functions is essential	65
5.3 4.4.3	Recognizing differences in national cultures, each CPs should define appropriate actions to ensure that the desired safety culture characteristics are achieved in the regulatory and operational organizations	64

PART IV

6. Implementation Activities - Actions

Action No.	Plant / Type	Topic	Action / Activity	Recommendation No.	Status	Completion
1	EDU/ PWR	natural hazards	Structures reinforcement against extreme climatic phenomena.	3.1.1.1.1, 3.1.1.1.2, 3.1.1.2.2, 3.1.1.2.3, 3.1.1.3.1, 3.1.8.1.5, 3.2.13.2.2, 3.2.13.3.1, 3.2.14.3.1, 3.2.17.1.4	finished	2014
2	ETE/ PWR	natural hazards	Fire brigade building reinforcement Note: Mobile fire brigade equipment as temporary solution (Action 84).	3.1.1.1.14, 3.1.1.4.1, 3.2.13.2.2, 3.2.13.3.1, 3.2.14.3.1, 3.2.17.1.1, 3.2.17.1.4	finished	2014
3	EDU/ PWR	natural hazards	Fire brigade building reinforcement Note: Mobile fire brigade equipment as temporary solution (Action 84).	3.1.1, 3.1.1.1.6, 3.1.1.2.3, 3.1.8.1.5, 3.2.13.2.2, 3.2.13.3.1, 3.2.14.3.1, 3.2.17.1.8	finished	2015
4	EDU & ETE/ PWR	natural hazards	In the study PSA to evaluate the risk resulting from the induced floods or fires after the seismic event.	3.1.2, 3.1.3, 3.1.1.2.3 3.1.2.1.1, 3.1.2.2.1, 3.1.2.3.1, 3.1.3.1.1, 3.1.8.3.1, 3.2.17, 3.2.17.1.2	finished	2014
5	EDU & ETE/ PWR	natural hazards	Ensuring the availability of regional weather forecasts and predictions for the shift engineer decision on the future operation and activities at the NPP.	3.1.3, 3.1.4.1.1	finished	2013
6	EDU/ PWR	natural hazards	Implementation of internal seismic monitoring system.	3.1.5, 3.1.5.2.1	finished	2014

7	EDU/ PWR	natural hazards	Completion of the procedures for managing extreme conditions in the site (wind, temperature, snow, earthquake).	3.1.6, 3.1.1.3, 3.1.6.1.1, 3.1.7.3.1, 3.1.8.1.2, 3.1.8.4.1, 3.2.1.2.7	finished	2013
8	ETE/ PWR	natural hazards	Completion of the procedures for managing extreme conditions in the site (wind, temperature, snow, earthquake).	3.1.6, 3.1.6.1.1, 3.1.7.3.1, 3.1.8.4.1, 3.2.1.2.7, 3.2.14.3.1	finished	2013
9	EDU & ETE/ PWR	natural hazards	Protection against flooding (Temelin Diesel generator station, Dukovany Emergency control centre).	3.1.7, 3.1.3.1.2, 3.1.7.1.2, 3.1.7.1.3, 3.1.7.1.6, 3.1.7.2.1, 3.1.7.2.2, 3.1.7.2.3, 3.1.7.2.4, 3.1.7.3.1, 3.1.7.4.1, 3.1.7.4.2, 3.2.14.1.2, 3.2.14.1.4, 3.2.14.2.1, 3.2.14.2.2, 3.2.14.3.1, 3.2.17.1.3	implemented	2012
10	EDU/ PWR	natural hazards	Hardening of entrances to the cable ducts against flooding – extreme rainfall.	3.1.7, 3.1.3.1.2, 3.1.7.2.3, 3.1.7.3.1	finished	2013
11	EDU/ PWR	natural hazards	Hardening of entrances to the diesel generator station against flooding – extreme rainfall.	3.1.7, 3.1.3.1.2, 3.1.7.2.3, 3.1.7.1.3	finished	2013
12	EDU & ETE/ PWR	natural hazards	Development of guidance on natural hazards assessments, including earthquake, flooding and extreme weather conditions, as well as corresponding guidance on the assessment of margins beyond the design basis and cliff-edge effects. Note: Worldwide action being performed under umbrella of WENRA and IAEA.	3.1.8, 3.1.8.1.6, 3.1.8.1.6, 3.1.8.1.9, 3.1.8.2.2, 3.1.8.3.2, 3.1.8.4.1, 3.2.17.1.5, 3.2.17.1.11	finished	2015
13	EDU / PWR	design issues	Provision of back-up water supply into SG from external mobile equipment using external connection points.	3.2.1.1.1, 3.2.1.1.5, 3.2.1.2.3, 3.2.1.2.4, 3.2.1.2.8, 3.2.2.1.3, 3.2.13.3.2, 3.2.15.1.4, 3.3.2.5.1	implemented	2012
14	ETE / PWR	design issues	Provision of back-up water supply into SG from external mobile equipment using external connection points.	3.2.1.2.5, 3.2.1.2.6, 3.2.1.2.8, 3.2.1.4.1, 3.2.13.3.2, 3.3.2.5.1	finished	2013
15	EDU / PWR	design issues	Provision of back-up coolant supply into depressurised reactor and storage pools with	3.2.1.1.2, 3.2.1.1.6, 3.2.1.1.7, 3.2.1.2.3, 3.2.1.3.1, 3.2.10.1.1,	finished	2013-2014

			additional and sufficient sources of coolant.	3.2.10.1.2, 3.2.10.1.5, 3.2.10.2.1, 3.2.10.2.2, 3.2.14.3.1, 3.2.14.3.2, 3.2.17.1.7, 3.3.2.2.3, 3.3.2.5.1		
16	ETE / PWR	design issues	Provision of back-up coolant supply into depressurised reactor and storage pools with additional and sufficient sources of coolant.	3.2.1.1.11, 3.2.1.2.6, 3.2.1.3.1, 3.2.10.2.5, 3.2.13.1.6, 3.2.14.3.1, 3.2.14.3.2, 3.3.2.1.3, 3.3.2.5.1	finished	2013-2014
17	EDU / PWR	design issues	Emergency cooling method – implementation of another emergency feedwater pump to SG.	3.2.1.2.4, 3.2.14.3.1, 3.2.14.3.2, 3.3.2.5.1	finished	2013-2015
18	EDU / PWR	design issues	Implementation of additional stable source of power supply (SBO-DG) for subsequent increasing of resistant against „station blackout"scenario.	3.2.1.1.9, 3.2.1.1.10, 3.2.1.1.13, 3.2.1.2.8, 3.2.2.1.1, 3.2.2.1.2, 3.2.2.1.4, 3.2.2.1.5, 3.2.2.2.1, 3.2.2.3.1, 3.2.3.2.1, 3.2.13.1.1, 3.2.14.3.1, 3.2.14.3.2, 3.2.15.1.9, 3.3.2.5.1	finished	2013-2014
19	ETE / PWR	design issues	Implementation of additional stable source of power supply (SBO-DG) for subsequent increasing of resistant against „station blackout" scenario.	3.2.1.2.8, 3.2.2.2.1, 3.2.2.3.1, 3.2.3.2.2, 3.2.3.3.1, 3.2.5.1.1, 3.2.14.3.1, 3.2.14.3.2, 3.2.15.1.9, 3.3.2.5.1	finished	2013-2014
20	EDU / PWR	design issues	Implementation of alternative measures to ensure long term DC power supply in case of SBO, i. e., among the other measures, ensuring recharging of batteries in case SBO and implementation of measures to extend batteries discharging time.	3.2.1.2.4, 3.2.2.2.1, 3.2.3.1.1, 3.2.3.2.1, 3.2.14.3.1, 3.3.2.5.1	finished	2012-2016
21	ETE / PWR	design issues	Implementation of alternative measures to ensure long term DC power supply in case of SBO, i. e., among the other measures, ensuring recharging of batteries in case SBO and implementation of measures to extend batteries discharging time.	3.2.2.2.1, 3.2.3.1.3, 3.2.3.1.4, 3.2.3.2.2, 3.2.3.3.1, 3.2.13.1.7, 3.2.14.3.1, 3.3.2.5.1	finished	2013-2014
22	EDU&ETE / PWR	design issues	Provision of alternative fuel filling for long-term operation of DG including providing of fuel sources.	3.1.1.1.11, 3.1.8.1.7, 3.2.4.1.1, 3.2.4.2.1, 3.2.13.1.5, 3.3.2.5.1	finished	2013

23	EDU / PWR	design issues, EP&R	Provision of alternative methods of monitoring of key parameters necessary for technological accidents management.	3.2.5.1.1, 3.3.2.5.1, 4.2.7	implemented	2012
24	ETE / PWR	design issues, EP&R	Provision of alternative methods of monitoring of key parameters necessary for technological accidents management.	3.2.5.1.1, 4.2.7, 3.3.2.5.1	finished	2013
25	EDU / PWR	design issues	Provision of heat removal from the I&C systems for long-term monitoring of key parameters during SBO.	3.2.8.1.1, 3.2.8.2.1, 3.2.8.3.1, 3.3.2.5.1	finished	2013-2015
26	ETE / PWR	design issues	Provision of heat removal from the I&C systems for long-term monitoring of key parameters during SBO.	3.2.1.1.12, 3.2.1.2.6, 3.2.8.1.1, 3.2.8.2.1, 3.2.8.3.1, 3.2.17.1.12, 3.3.2.5.1	finished	2013-2015
27	EDU / PWR	design issues	Implementation of important measurements into post-accident monitoring system – the addition of RA situation measurement and SFP condition into PAMS.	3.2.5.1.1, 3.2.1.2.8, 3.2.10.1.4, 3.2.10.3.1, 3.3.2.5.1, 3.3.4.4, 3.3.12.1.1	finished	2013-2015
28	ETE / PWR	design issues	Exclude the mid-loop modes of operation during shutdown unit state (organizational measure).	3.2.6.3.1	implemented	2012
29	EDU / PWR	design issues	Provision of heat removal from the key safety component during SBO.	3.2.8.1.1, 3.2.8.2.1, 3.2.8.3.1	finished	2015
30	ETE / PWR	design issues	Provision of heat removal from the key safety component during SBO.	3.2.8.1.1, 3.2.8.2.1, 3.2.8.3.1	finished	2015
31	EDU / PWR	design issues	Completion of the project of control rooms habitability.	3.2.9.2.1, 3.3.2.2.2	finished	2015
32	EDU / PWR	design issues	Completion of SFP status parameters and the other important measurements into PAMS.	3.2.10.3.1, 3.3.12.1.1	finished	2013-2015
33	EDU / PWR	design issues	Implementation of the ventilator towers for ensuring independent ultimate heat sink.	3.1.1.2.1, 3.1.1.2.3, 3.1.8.1.1, 3.1.8.2.1, 3.1.8.2.2, 3.2.1.1.3, 3.2.1.1.4, 3.2.1.2.1, 3.2.1.2.2, 3.2.1.2.3, 3.2.1.2.4, 3.2.11.1.1, 3.2.11.2.1	finished	2014-2016

34	EDU / PWR	design issues, EP&R	Provision of back-up power supply of Security Technical Systems and shelters and power supply of telephone exchanges, communications, lighting, turnstiles.	3.2.2.1.4, 3.2.12.1.1, 3.2.13.1.3, 3.2.13.1.4, 3.3.9.1.3, 4.2.14	finished	2013-2014
35	ETE / PWR	design issues, EP&R	Provision of back-up power supply of telephone exchanges, communications and radio network.	3.2.2.1.10, 3.3.9.1.5, 4.2.14	finished	2013-2014
36	ETE / PWR	design issues	Ensuring long-term capacity of external technical and professional (off site) support for difficult technological extraordinary events	3.2.12.1.3, 3.2.13.1.6, 3.2.15.1.8, 3.2.15.1.10, 3.2.15.2.2, 3.2.17.1.15, 3.3.3.2.3, 3.3.3.3.1, 3.3.4.4, 3.3.14.1.2	finished	2013
37	EDU / PWR	design issues	Ensuring long-term capacity of external technical and professional (off site) support for difficult technological extraordinary events	3.1.1.1.9, 3.2.12.1.2, 3.2.15.1.5, 3.2.15.1.8, 3.2.15.1.10 3.2.15.2.2, 3.3.3.2.3, 3.3.3.3.1, 3.3.4.4, 3.3.14.1.1	finished	2013
38	EDU / PWR	design issues	Provision of alternative mobile devices for alternative fluids pump and provision of power supply	3.2.1.3.1, 3.2.13.1.1, 3.2.13.1.2, 3.2.13.2.1, 3.2.13.3.2, 3.2.15.3.1	finished	2014
39	ETE / PWR	design issues	Provision of alternative mobile devices for alternative fluids pump and provision of power supply	3.2.1.3.1, 3.2.13.2.1, 3.2.13.3.2, 3.2.15.3.1	finished	2014
40	EDU / PWR	design issues	Ensuring sufficient capacity and expertise of on-site personnel for multi-unit long term accidents and for the whole site affected	3.1.1.1.9 , 3.1.8.1.4, 3.1.8.1.8,, 3.1.8.2.2, 3.1.8.4.1, 3.2.1.3.1, 3.2.2.1.6, 3.2.12.1.2, 3.2.15.1.1, 3.2.15.1.2, 3.2.15.1.8, 3.2.15.2.2, 3.2.15.3.1, 3.3.3.2.3, 3.3.3.3.1, 3.3.4.4	finished	2014

41	ETE / PWR	design issues	Ensuring sufficient capacity and expertise of on-site personnel for multi-unit long term accidents and for the whole site affected	3.2.1.1.10, 3.2.1.1.13. 3.2.1.3.1, 3.2.2.1.8, 3.2.2.1.9, 3.2.12.1.3, 3.2.13.1.6, 3.2.15.1.1, 3.2.15.1.2, 3.2.15.1.8, 3.2.15.2.2, 3.2.15.3.1, 3.2.17.1.15, 3.3.3.2.3, 3.3.3.3.1 3.3.4.4	finished	2014
42	EDU&ETE / PWR	design issues, EP&R	Provision of periodic verification of the functionality of alternative mobile devices for mitigation of damage	3.2.16, 3.2.14, 4.2.3, 3.2.1.3.1, 3.2.13.3.2, 3.2.15.3.1, 3.2.16.2.3	finished	2015
43	EDU&ETE / PWR	design issues, EP&R	Provision of periodic practicing of the using of alternative mobile devices for mitigation of damage	3.2.16, 3.2.14, 4.2.3, 3.2.1.3.1, 3.2.13.3.2, 3.2.15.3.1, 3.2.16.2.3, 3.3.2.3, 3.3.4.4	finished	2015
44	EDU&ETE / PWR	SAM	Analyse states of severe accidents according to the current "state of art" to reduce uncertainty in the resistance of equipment and in the preparation of procedures for the activities management	3.2.17, 3.2.15.2.4, 3.2.17.1.11, 3.2.17.2.1 3.3.2.2.1, 3.3.16.2, 3.3.16.4, 3.3.16.5, 3.3.16.6	in progress	constantly
45	EDU&ETE / PWR	Natural hazards	Assessment of seismic hazard of sites	3.2.17, 3.1.5.1.1, 3.1.8.5.1, 3.2.14.1.3	finished	2012
46	EDU / PWR	SAM	Completion of projects of increase the capacity of the system for the hydrogen disposal during severe accidents	3.3.2, 3.3.10, 3.3.2.1.1 3.3.2.2.3, 3.3.2.3.2, 3.3.10.1.1, 3.3.10.2.1	finished	2013-2015
47	ETE / PWR	SAM	Completion of projects of increase the capacity of the system for the hydrogen disposal during severe accidents	3.3.2, 3.3.10, 3.3.2.2.3 3.3.2.4.2, 3.3.2.3.2, 3.3.10.1.3, 3.3.10.2.1	finished	2013-2015
48	EDU / PWR	SAM	Implementation of external RPV cooling – melted core detention inside RPV (Installation of means for flooding A004, modification of RPV heat shield)	3.3.2, 3.3.10, 3.3.2.1.2 3.3.2.2.3, 3.3.2.4.1, 3.3.2.4.4, 3.3.2.3.2, 3.3.16.9	finished	2015
49	ETE / PWR	SAM	Completion of analysis and propose a strategy and schedule for implementation of measures for preservation of long-term containment	3.3.2, 3.3.10, 3.2.17.1.16, 3.2.17.1.18, 3.3.2.2.3, 3.3.2.4.1, 3.3.2.4.4, 3.3.2.3.2,	finished	2014

			integrity (to stabilize melt and prevent overpressure)	3.3.16.7, 3.3.16.9		
50	ETE / PWR	SAM	Implementation of measures for maintaining long-term containment integrity according to selected severe accident management strategies	3.3.2, 3.3.10, 3.2.17.1.3, 3.3.2.2.3, 3.3.2.4.4, 3.3.2.3.2,	in progress	2022
51	ETE, EDU/ PWR	SAM	Verification of the correctness of assumptions about the functioning of the equipment during beyond design conditions and external risks, including possible measures to ensure functionality according to SAMG	3.3.3, 3.2.15.2.4, 3.2.16.1.2, 3.2.17.2.1, 3.3.2.3.1, 3.3.2.4.3, 3.3.3.1.1, 3.3.3.2.2, 3.3.3.2.3, 3.3.16.1	finished	2014
52	EDU&ETE / PWR	SAM	Issuance of a new procedure for coping with extreme conditions at sites (wind, temperature, snow, earthquake)	3.3.4, 3.1.1.3, 3.1.1.1.4, 3.1.6.1.1, 3.1.8.4.1, 3.2.1.2.7, 3.3.3.2.3, 3.2.15.1.6, 3.2.17.1.11	finished	2013
53	EDU&ETE / PWR	SAM	Processing of guides for the use of alternative technical means (FLEX, EDMG, etc. …)	3.3.4, 3.1.1.1.4, 3.1.1.1.10, 3.1.1.1.12, 3.1.1.1.18, 3.1.7.1.1, 3.1.7.1.5, 3.1.8.1.3, 3.2.1.1.5, 3.2.1.1.8, 3.2.1.1.14, 3.2.1.2.3, 3.2.2.1.2, 3.2.2.1.10. 3.2.4.3.1, 3.2.10.2.3, 3.2.15.1.3, 3.2.15.1.7, 3.2.15.2.1, 3.2.15.2.3, 3.2.17.1.9, 3.3.3.2.3, 3.3.3.4.1, 3.3.4.3.1, 3.3.8.1.2, 3.3.8.1.4	finished	2015
54	EDU&ETE / PWR	SAM	System setup of AM procedures and guidelines verification and validation	3.3.5, 3.3.4.4, 3.3.5.1.1	finished	2014
55	EDU&ETE / PWR	SAM	System setup of training (drills), exercises and training for severe accident management according to SAMG, including the possible solutions of multi-unit severe accident	3.3.6, 3.3.7, 3.3.4.4, 3.2.1.1.5, 3.2.16.1.1, 3.2.16.2.1, 3.2.16.2.2, 3.3.6.1.1, 3.3.16.8	finished	2014

56	EDU&ETE / PWR	SAM, design issues	Development and implementation of guidelines for severe accident management during shutdown conditions and in SFP (SSAMG)	3.3.8, 3.2.14, 3.2.6.1.1, 3.2.6.1.2, 3.2.6.1.3, 3.2.6.2.1, 3.2.10.1.3, 3.2.10.1.7, 3.2.10.2.4, 3.2.10.2.6, 3.2.16.2.1, 3.3.3.4.1, 3.3.4.1.1, 3.3.4.1.2, 3.3.4.2.1, 3.3.4.3.2, 3.3.8.1.1, 3.3.8.1.3, 3.3.8.2.1, 3.3.8.2.2, 3.3.8.2.3, 3.3.8.2.4, 3.3.10.1.2	finished	2014
57	EDU&ETE / PWR	SAM, EP&R	Providing of alternative means for internal and external communication, notification and warning of staff and population during loss of existing infrastructure	3.3.9, 4.2.7, 3.1.1.1.7, 3.1.1.1.15, 3.2.2.1.10, 3.2.14.1.1, 3.3.9.1.1, 3.3.9.1.2, 3.3.9.1.4, 3.3.9.2.1, 3.3.9.2.2, 3.3.9.3.1	finished	2013
58	EDU&ETE / PWR	SAM	Analysis of habitability MCR/ECR during severe accidents, including the impact on MCR/ECR unaffected unit	3.3.12, 3.2.9.1.1, 3.2.9.2.1, 3.2.9.2.1, 3.2.17.1.17, 3.3.2.2.2, 3.3.12.1.2, 3.3.12.3.1, 3.3.13.2.1, 3.3.16.4	finished	2013
59	EDU&ETE / PWR	SAM	Providing of alternative means of abnormal occurrence management during loss of primary control centres (Emergency Control Centre, Physical Protection Control Centre, Fire Protection Control Centre)	3.3.13, 3.1.1.15, 3.1.1.1.8 , 3.1.1.1.13, 3.1.1.1.16, 3.1.7.1.4, 3.2.2.1.7, 3.2.2.1.10, 3.3.9.2.2, 3.3.12.3.1, 3.3.13.1.1, 3.3.13.1.2, 3.3.13.1.3, 3.3.13.1.4, 3.3.13.1.5, 3.3.13.3.1, 3.3.14.2.1	finished	2014 - analysis
60	EDU&ETE / PWR	SAM	Providing of necessary technical means, protection of personnel and equipment and background during the period outside the implementation of interventions (24 hours / 7 days)	3.3.14, 3.3.4.4, 3.1.1.1.8, 3.1.1.1.16, 3.1.1.1.17, 3.1.7.1.2, 3.1.7.1.6, 3.1.7.2.4, 3.1.7.4.3, 3.2.2.1.7, 3.2.14.1.4, 3.2.14.2.1, 3.2.15.1.6, 3.2.15.1.7, 3.2.17.1.9, 3.2.17.1.10 3.3.2.1.3, 3.3.9.2.2	finished	2013

61	EDU&ETE / PWR	SAM	Analysing of conditions and severe accident scenarios based on the current "state of art" and the results of experiments from research of materials behaviour during severe accident	3.3.16, 3.2.17.2.1, 3.3.2.2.1, 3.3.3.3.1, 3.3.10.1.1, 3.3.10.1.3, 3.3.16.1, 3.3.16.2, 3.3.16.4, 3.3.16.5, 3.3.16.6	in progress	constantly
62	national	national organisations	Reviewing of legislation in the field of nuclear energy to reflect WENRA Reports	4.1.1, 4.1.2, 3.3.1, 4.3.6	finished	2015
63	national	national organisations cross-cutting issues	Providing of transparency and open communication with the public/stakeholders	4.1.5, 5.1, 3.3.9.4.1	in progress	constantly
64	national	national organisations cross-cutting issues	Consolidation of safety culture – regular assessment of safety culture by regulatory body	4.1.7, 5.3	in progress	constantly
65	national	cross-cutting issues	Setting up open and professional relationship with the regulatory bodies – the realization of regular summits of SUJB with the operator	5.2	in progress	constantly
66	national	national organisation, EP&R	Regular update of emergency plans	4.1.4, 4.2.1, 4.2.2, 4.2.4, 4.2.5, 4.2.6	in progress	constantly
67	national	International Cooperation	International cooperation – participation of experts of the Czech republic (regulatory body and operator) in international programs and activities of IAEA, OECD/NEA, WANO, EC-ENSREG, WENRA and bilateral cooperation	4.3.1, 4.3.2, 4.3.3, 4.3.4, 4.3.5	in progress	constantly
68	national	SAM	Analyses of potential accident scenarios resulting in large volumes of contaminated water including definition of remedial measures	3.3.11, 3.3.11.1.1	finished	2015

69	national	SAM	Upgrade PSA LEVEL 2 for both NPPs for the identification of plant vulnerabilities, quantification of potential releases related to extreme external conditions	3.3.15, 3.1.8.3.1, 3.3.3.2.1, 3.3.5.2.1, 3.3.15.2.1, 3.3.16.3	Finished at EDU NPP, partially finished at ETE NPP	2018
70	national	natural hazard	Seismic PSA including analysis of secondary effects with a proposals for remedial measures	3.1.3, 3.1.1.2.3, 3.1.2.1.1, 3.1.2.2.1, 3.1.2.3.1, 3.1.3.1.1, 3.1.8.3.1, 3.1.8.5.1, 3.2.17.1.2, 3.3.15.1.1, 3.3.15.2.1, 3.3.16.3	finished	2015
71	national	national organisations	IRRS missions invited for November 2013	4.1.3	finished	November 2013
72	national	national organisations	Post- Fukushima safety reassessments and action plans – stress tests and follow up action plan	3.1.1.2.2, 3.2.3.2.3, 4.1.6	in progress	constantly
73	ETE/PWR	design issues	Analysis for the SG gravity feeding use in EOPs is to be finished and subsequently EOPs are to be updated	3.2.1, 3.2.1.3.1	finished	2014
74	EDU, ETE/PWR	design issues	Analysis of off-site power connections reinforcement and subsequent reinforcements, if needed	3.2.2.3.2	finished	analysis 2013, modifications (if needed) 2015
75	EDU, ETE/PWR	design issues	Performing batteries capacity real load test	3.2.3, 3.2.3.1.1, 3.2.3.1.4, 3.2.17.1.6, 3.2.17.1.13	finished	2015
76	EDU, ETE/PWR	design issues	Alternative supply of selected valves from mobile power supply sources	3.2.12, 3.3.2.5.1	finished	2015
77	EDU, ETE/PWR	SAM	During the preparation of EDMG guidelines for the use of alternative technical means an update of SAMG will be performed including	3.3.4	in progress	2018

			extensions of SAMGs by incorporating long-term activities in accordance with the findings of EPRI - ETE, EDU			
78	EDU/ PWR	design issues	Procurement of additional fire truck to cope with multiunit accidents.	3.1.1.1.6, 3.1.1.1.14	finished	2013
79	EDU, ETE/ PWR	design issues	Preparation and validation of procedures for the use of the safety DG of the other unit in case of an SBO.	3.2.3.1.3	finished	2013
80	EDU, ETE/ PWR	design issues	Summarisation of existing documents that prove long term MCP seal tightness in SBO situation, additional analyses (if found necessary).	3.2.7.1.1	finished	2013
81	EDU, ETE/ PWR	design issues	Feasibility analysis of heat transfer from the SFSP without an additional water supply.	3.2.10.1.6, 3.2.17.1.14	finished	2013
82	ETE/ PWR	design issues	Selected valves power supply reconnection to batteries for containment isolation during SBO.	3.2.12.2.1, 3.3.12.1.3	finished	2012
83	ETE, EDU/ PWR	design issues	Feasibility study based on existing analyses that prove flow paths and access availability.	3.2.12.3.1	finished	2014
84	ETE, EDU/ PWR	natural hazards	Procurement of fire brigade truck equipped with necessary devices to cope with selected SA.	3.1.1.1.6, 3.1.1.1.14	finished	2013

7. Conclusions

All measures contained in the Action Plan are to be completed by the end of 2022. Any problems that may affect implementation of the Action Plan will be considered case by case between the license holder and regulatory authority. If the measure included in the Action Plan is to perform study or analysis, new measures may be identified based on its results. Action plan will be updated accordingly based on results of these considerations. Based on any new information resulting from still on-going investigations of Fukushima accident new measures may be included in the Action Plan as well. Existing deadlines indicated in the Action Plan are mainly allowed by the fact that many of listed measures both Dukovany NPP and Temelin NPP are already in advanced stage of implementation since they were proposed before the Fukushima events on the basis of Periodic Safety Reports results. For example, in case of Dukovany NPP this applies particularly to the seismic hardening to value of 0.1 g acceleration, which was a result of periodic safety review (PSR) of this plant made in 2009.
The core of measures in the Action Plan were proposed by license holder ČEZ, a.s. and accepted by SÚJB (State Office for Nuclear Safety) as nuclear safety regulatory authority. Both Dukovany NPP and the Temelín NPP developed so called Safety Increasing Program (SIP) based on conclusions of the National Stress Tests Report, lessons learned from EU stress tests peer review exercise and previous periodic safety review findings. This initiative is in line with licensee prime responsibility for safety principle defined in the law. After regulatory review the licensee list was supplemented by measures/actions requested by SÚJB. This Action Plan represents complete set of measures (as of 31st December 2012) to strengthen safety of Czech nuclear power plants in response to the Fukushima nuclear power plant accident. Based on article 17 of the Atomic Act this final version of Action Plan has been transferred to the licensee ČEZ, a.s. via letter of SÚJB Chairperson together with description of procedure that is being applied for regulatory oversight of its implementation. In particular, Action Plan implementation will be monitored through scheduled inspections continuously. If needed, new measures will be included or modification of already existing measures will be done in accordance with principles mentioned in previous paragraph.
Both the Action plan and the conclusions of SÚJB inspections are published on the SÚJB website.

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