

Post-  
Fukushima  
accident

ENSREG ■  
National Action  
Plans Workshop

Summary Report

# **SUMMARY REPORT**

## **ENSREG NATIONAL ACTION PLANS WORKSHOP**

### **Executive Summary**

The main objective of the ENSREG National Action Plan (NACPs) Workshop held on 22-26 April 2013 in Brussels was to peer review the contents and status of implementation of the NACPs via a common discussion. The workshop supported the consistency, as well as promoted sharing of commendable practices, experiences and challenges within European countries. The discussion took place in a very open and constructive but still challenging atmosphere. Transparency on the implementation of lessons learned from the Fukushima Dai-ichi accident was provided. Sixty four experts from 21 European Union member states, the European Commission, Switzerland and the Ukraine as well as six observers from three additional countries (Armenia, Canada and Taiwan) and the IAEA and two invited guests participated.

NACPs describe the actions, identified following the Fukushima Dai-ichi accident, that were taken, planned or implemented and their schedule to improve the safety of nuclear power plants (NPPs). The scope of the peer review workshop was focused on the topics of the EU Stress Tests (natural external hazards, loss of safety systems/design issues, and management of severe accidents).

The Fukushima Dai-ichi accident highlighted *inter alia* the importance of the Defence-in-Depth principle and the continued need to ensure the design basis adequately addresses external hazards. All countries identified analysis needs, hardware improvements, procedural modifications and regulatory actions, and corresponding implementation schedules in their NACPs. The NACP Workshop recognized the importance of the Periodic Safety Review process as a powerful tool to be used for continuous improvement of nuclear power plants. Maintaining containment integrity under severe accident conditions remains an important issue for accident management. This is well recognized and related activities are included in most NACPs. All participating countries are strongly committed to the issue of transparency of their work and demonstrated related improvements.

All countries are committed to follow-up the implementation of identified improvement actions until their finalisation.

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# 1. INTRODUCTION

## 1.1 Overview of the EU Stress tests process

In the aftermath of the nuclear accident that occurred at the Fukushima Dai-ichi nuclear power plant in Japan on 11 March 2011 the European Council requested at its meeting of 24-25 March 2011 that European Nuclear Safety Regulators Group (ENSREG) and the European Commission should review all EU nuclear power plants on the basis of a comprehensive and transparent risk and safety assessment (“stress tests”) in light of the Fukushima lessons learned. The Council invited the ENSREG and the European Commission to develop the scope and modalities for the stress tests for NPPs with the support of the Western European Nuclear Regulators’ Association (WENRA). The stress tests were conducted by the European NPP licensees and reviewed by the national regulators who prepared national reports. The focus on the stress tests was in the following three topics: natural external events, including earthquake, flooding and extreme weather conditions, the loss of safety functions and severe accident management.

The national reports were submitted in December 2011 and peer reviewed through a process organised and overseen by ENSREG. Country visits were undertaken as part of the peer review. The outcome of the stress tests were one main Peer Review report and 17 country peer review reports summarising the studies made and actions decided in different countries. The report also included many recommendations and suggestions to further improve safety of the European NPPs. ENSREG endorsed the stress tests peer review report and published a joint statement dated 26 April 2012, which concluded that follow-up activities would occur through an action plan developed by ENSREG. This ENSREG Action Plan as of 25 July 2012 was agreed on 1 August 2012. ENSREG also published in October a compilation of recommendations and suggestions which lists all recommendations and suggestions found in the stress test peer review report grouping them according to the peer review topics.

In addition to the EU stress tests, the participating countries took into consideration the 2<sup>nd</sup> Extraordinary Meeting of the Contracting Parties to the Convention of Nuclear Safety, which was held in August 2012 and discussed the lessons learned from the Fukushima Dai-ichi NPP accident in six topical areas: (1) external events, (2) design issues, (3) severe accident management, (4) national organisations, (5) emergency preparedness and response and post-accident management (off-site), and (6) international co-operation.

## 1.2 National action plans

The ENSREG Action Plan of 25 July 2012 requested, that each national regulator develop and make public its national action plan (NACp) associated with post-Fukushima lessons learned and stress test peer review recommendations and suggestions by the end of 2012. Further it was mandated by ENSREG that a National Action Plans workshop will be held at the beginning of 2013 to discuss contents and status of implementation of the national action plans. ENSREG member states and also other European countries that took part in the peer review of the EU stress tests were envisaged as participants.

The NACp provides an update on the implementation status of:

- a. National regulator conclusions from their national stress tests as documented in their national reports;
- b. Recommendations in the ENSREG main and country peer review reports;
- c. Additional recommendations arising from the CNS; and,
- d. Additional activities derived from national reviews and related decisions.

## **2. WORKSHOP PROCESS**

### ***2.1 Preparation of the workshop and Scope***

In January 2013, the NAcPs of the participating countries were published at the ENSREG website. Ahead of the workshop, each NAcP was reviewed by other participating countries which raised questions and comments. These questions and comments were sent to the relevant country and rapporteurs to be taken into account in the national presentation and rapporteurs' report. Questions and comments were also raised by the public to be taken into account in the same way (see paragraph 2.4 below).

The scope of the peer review workshop comprised the three topics of the EU stress tests, which are the same as the topics 1-3 of the 2<sup>nd</sup> Extraordinary CNS Meeting: (1) External Hazards, (2) Loss of Safety Systems / Design Issues, (3) Management of Severe Accidents.

### ***2.2 Objectives***

The main objective of the workshop was to present the national action plans and to peer review the contents and status of implementation of the NAcPs via a common discussion. The peer review considered the extent to which the relevant post Fukushima assessment outcomes as well as ENSREG and CNS recommendations and suggestions have been taken into account. The purpose of a common discussion was to support consistency and promote sharing of good practices and experiences and to identify challenges.

The review was not intended to provide a technical assessment of the NAcPs individual measures. Nevertheless, appropriate technical aspects were considered to the extent necessary to understand the actions and improvements identified.

### ***2.3 Conduct of the Workshop***

The contents and status of implementation of the national action plans were presented and peer reviewed via a common discussion in the ENSREG National Action Plans workshop held in Brussels on 22-26 April 2013. Participants were ENSREG member states and also other European countries that participated in the peer review of the EU stress tests. Sixty four experts from 21 European Union member states, European Commission, Switzerland and the Ukraine, 31 additional experts to support their national presentations and discussion as well as six observers from three additional countries (Armenia, Canada and Taiwan) and the IAEA and two invited guest speakers participated.

All EU nuclear power member states (15) and Switzerland and Ukraine presented their NAcP. Most of the national presentations were structured taking account of the following items:

- a. To what extent the NAcP encompasses the general recommendations and suggestions as well as country specific recommendations arising from the Peer Review and the conclusions of the Extraordinary CNS meeting of August 2012.
- b. The timeframe of the implementation of such recommendations and comments on the status of the main actions (specifying what regulatory steps / measures have been taken as a result of the stress tests).
- c. The transparency measures
- d. Nationally identified good practices and challenges.

The presentations also took into account questions or comments already raised before the workshop. All national report presentations and discussions at the workshop were made in plenary sessions.

The presentations and discussions of NAcPs were followed by rapporteurs, who collated the outputs and drafted country specific reports. There were in total 12 rapporteurs: 2 rapporteurs jointly covered 3 NAcPs. The rapporteurs were provided from both the nuclear and non-nuclear countries participating in the workshop. No rapporteur was assigned to monitor his/her own country.

A special session of the workshop was dedicated to the use of peer review processes for improvement and harmonisation in nuclear safety. James E. Lyons (IAEA) and Anton von Gunten (NPP Mühleberg, Switzerland) presented key-note addresses on the safety improvements through IRRS and other mission services provided by IAEA and OSART and WANO peer review missions from the operator's perspective. In the discussion it was clearly stated that these processes contribute substantially to continuous improvement in nuclear safety. They require profound preparation and full commitment by all persons involved. To further improve the review process all countries are strongly encouraged to include always a follow up mission.

It was stated that in comparison to the stress test peer review the NAcP workshop had a different scope and a focussed specification (Terms of Reference). The sharing of insights into the NAcPs and thus the gained transparency regarding the implementation of safety improvements throughout Europe constitutes a great value.

The workshop concluded that a follow-up peer review with appropriate mandate and Terms of Reference based on WENRA reference levels and safety objectives would be valuable by providing an opportunity for exchange of information among participants. It would also contribute to transparency, in particular if conducted regarding the implementation of identified factual modifications to the European NPPs. Such a follow-up peer review could be conducted in 2015 or later when the results of important studies and assessments are available. This review should make use of other coordinated reviewing processes where appropriate. This proposal should be considered by ENSREG for its future plans.

## ***2.4 Transparency of the Stress Tests follow-up process***

One of the key objectives of ENSREG is to improve the overall transparency on issues relating to the safety of nuclear installations and effective radioactive waste management. Therefore possibilities for public interaction had been provided during the EU stress tests follow-up process. The ENSREG Action Plan provided that all regulators published their NAcPs on their website. They are also available in English language via the ENSREG homepage.

Furthermore the general public was informed via the ENSREG website about the peer review process. From 25 February to 22 March 2013 the public had the opportunity to give comments and put questions regarding the NAcPs and the peer review workshop via the ENSREG website. These comments and questions were an additional input to the workshop.

At the end of the workshop (26 April 2013) a press statement of the workshop President was issued. The Peer Review Workshop Report will be published after adoption by ENSREG (mid-May 2013) and will be presented at the ENSREG Conference on Nuclear Safety (11-12 June 2013) to the public.

## **3. FINDINGS (overview)**

### ***3.1 The consistency and scope across the NAcPs***

All countries followed the ENSREG guidance for the content of the NAcP and almost all addressed the items from the ENSREG compilation of recommendations and suggestions completely. In addition all countries referenced the recommendations from the country peer review report and from the additional fact finding site visit. A number of countries also covered the aspects identified by the 2<sup>nd</sup> Extraordinary Meeting of the CNS in their NAcPs. By this, an almost common basis for addressing the recommendations was used in all countries although there were some differences in the level of detail of information.

Several countries made reference to their national reviews which were carried out before or in parallel to the EU stress tests. Some additional documents, including the IAEA Action Plan and those from European Commission and US NRC, were also used by some countries as an additional source for recommendations or suggestions.

### **3.2 Measures to address the recommendations of the ENSREG Action Plan**

All countries identified analysis needs, hardware improvements, procedural modifications and regulatory actions, and corresponding implementation schedules in their NAcPs. In a number of countries significant safety improvement programmes had been completed or were on-going prior to the Fukushima accident. On-going programmes were updated to reflect the ENSREG recommendations and new plans were prepared. Further national review is still pending, on the basis of on-going investigations and analyses, and may lead to additional measures.

As part of the continuing improvement process many regulators are updating their regulatory requirements taking into account the lessons learned from the Fukushima Dai-ichi accident. The implementation of new requirements may lead to additional measures to improve safety.

#### **3.2.1 Natural hazards: assessment, prevention and mitigation of consequences**

The Fukushima Dai-ichi accident highlighted *inter alia* the importance of the Defence-in-Depth principle and the continued need to ensure the design basis adequately addresses external hazards. All participating countries reported their analyses of safety margins under extreme natural hazards. Measures to further increase the robustness of the NPPs are planned or have already begun. In this respect, the definition of robustness, as well as the determination of safety margins beyond design basis was discussed.

A number of countries presented concepts of bunkered or hardened systems. These systems provide additional DC- and AC-Power, cooling water and crisis management premises and equipment which are protected against extreme external events.

In all countries a variety of additional mobile equipment like pumps, diesel generators, air compressors and other equipment has already been procured, much of this very shortly after the Fukushima accident. The use of specialized mobile equipment is under further investigation in many countries which have already begun installing connection points for this equipment. The design requirements for this equipment were also discussed during the workshop.

During the workshop the analyses of decay heat removal from the reactor core and the spent fuel pools in case of long-lasting total loss of AC power or a loss of ultimate heat sink was discussed. Some countries are planning new permanently installed and partly bunkered systems to ensure the decay heat removal from reactor core and spent fuel pools. It should be noted that in some countries such bunkered safety systems have been installed for a number of years, providing safety against man-made external events and external hazards. Some countries rely more on mobile equipment to ensure decay heat removal from reactor core and spent fuel pools in case of extreme situations and loss of the safety systems.

#### **3.2.2 Periodic Safety Review**

The NAcP Workshop recognized the importance of the Periodic Safety Review (PSR) process as a powerful tool to be used for continuous safety improvement of nuclear power plants. In particular the peer review of the EU stress test highlighted that PSR should include the re-evaluation of natural hazards and relevant plant provisions. The PSR shall confirm the compliance of the plant with its licensing basis and also identify possible safety improvements based on a review of applicable current safety standards, operating experience, research results and internationally recognised good practices.

All participating countries have introduced the general requirements for PSR in the national regulations, although the PSR methodology varies between countries. Some countries additionally integrate probabilistic safety analysis to assess the balance of the safety design and identify further improvements of the NPPs. Typical interval is 10 years. In some countries positive results of a preceding Periodic Safety Review are a prerequisite for a continued validity or a further 10-years prolongation of the operation license of the reviewed NPP.

### **3.2.3 Containment integrity**

Maintaining containment integrity under severe accident conditions remains an important issue for accident management. This is well recognized and related activities are included in most NAcPs.

Filtered containment venting is a well-known approach to prevent containment overpressure failure in most light water reactor (LWR) and has already been implemented in certain countries. Some other countries are now implementing the filtered venting system while others are considering improving the existing ones, for example the filtering efficiency or seismic qualification.

In other LWRs the approach for containment overpressure protection is different. Several countries are implementing or analysing different complementary technical measures for long-term heat removal from the containment. In this respect, the existing cooperation among operators as well as regulators respectively between countries with similar reactor designs was further encouraged.

The installation of passive autocatalytic recombiners (PAR) to manage hydrogen in the containment is well known as an important safety upgrading measure in PWRs and CANDUs where appropriate. As a result of the Fukushima Dai-ichi accident many countries are now installing PARs to cope with beyond design basis accident conditions or are reconsidering their number and position. In most BWRs hydrogen management is achieved by nitrogen inertisation.

There are different approaches for cooling and stabilising molten core. For some of the smaller reactors in Europe in-vessel retention (IVR) is considered, and in some plants implemented. For other reactors this IVR-concept is also under investigation. For other plants cooling and stabilizing of molten core is dealt with in the frame of severe accident management guidelines and other concepts for stabilising molten core are under investigation.

## **3.3 Schedule of the implementation of the NAcPs**

All countries outlined a stepwise process in implementing their improvement measures. Several countries divided their actions into short (up to 2012), medium (up to 2015) and longer (up to 2020) term. Several hardware improvements commenced in the immediate aftermath of the Fukushima Dai-ichi accident. For example this included ordering mobile diesel generators and mobile pumps. Other improvements require detailed and time-consuming analyses and design, and/or regulatory approval beforehand and therefore are planned in medium or long term. The timing of some improvement measures is in some cases limited by the manufacturing and contracting capability for certain equipment.

Further generic or plant specific analyses are on-going or will be performed to review the robustness of the NPP and to identify appropriate backfitting and improvement measures. The scope and the number of such analyses differ between the countries. Most countries conduct investigations which are expected to determine scope and design of further measures. The finalisation dates of such analyses are mentioned by all countries. The resulting schedule for further improvements is pending the outcome of the analyses.

The workshop noted that many actions, in particular analyses and reviews, have been completed or are scheduled for completion by 2014. Major modifications are expected to be implemented in 2015 – 2018. The latest date mentioned is 2020.



### **3.4 Transparency of the NAcPs and the process of the implementation of the tasks identified within them**

All participating countries are strongly committed to the issue of transparency of their work. All regulators posted the NAcP in English, about half of them also in their national language on a dedicated website. In addition the NAcPs are available in English via the ENSREG homepage.

During the workshop several countries reported on informing and engaging the public. This included regular information provision on the on-going status of implementation to the general public or the media and in some cases also to the National Parliament. A number of countries engage with stakeholders, in particular those in the vicinity of the NPP, via local information committees/groups.

Many Countries plan to provide information on status of implementation of their National Action Plan on a regular basis, at least annually. Such information will be published, e.g. via the national regulators website.

All countries are committed to follow-up the implementation of their NAcP until all measures have been finalised. Many measures and activities are planned to be finalized until end of 2014 and it is expected that some studies will be followed up by hardware measures. Therefore, added value is seen in conducting a follow-up peer review in 2015 or later.

### **3.5 Commendable aspects (good practices, experiences, interesting approaches) and challenges**

The most commendable aspects and the challenges identified during the presentations and discussions in the workshop are summarized in this chapter. They are also included in the country-by-country main findings.

#### **3.5.1 Commendable aspects**

The following items have been presented and discussed in the NAcP workshop and are considered as commendable aspects:

- to pursue a margin analysis for high earthquake loads and to identify therein the most resisting systems
- to use PSR process for improving the nuclear safety of NPPs
- backfitting hardware, e.g. in the domain of severe accident management and/or by using bunkered system to strengthen the robustness of NPPs
- utilise PSAs as a tool to identify improvement measures
- accelerating existing improvement programmes because of Fukushima
- including all nuclear facilities into the scope of a national stress test
- exceeding the scope of the ENSREG stress test as applicable ,e.g. concerning the influence of external contractors to the safety of NPPs, possible provisions against consequences from the loss of large areas of the NPP

#### **3.5.2 Challenges**

The following items are considered as challenges:

- obtain a complete understanding of the Fukushima Dai-ichi accident and highlight the lessons learned

- completing the studies necessary to re-evaluate the strategy for severe accident management taking into account the lessons learned of the Fukushima Dai-ichi accident
- exchanging results of PSR between countries
- reassessing natural hazards systematically in the PSR process
- developing requirements for design of bunkered equipment
- developing requirements for design, qualification and maintenance of mobile equipment that is not regularly used
- qualifying instrumentation for severe accident conditions especially in the long term
- demonstrating that the necessary resources and arrangements are in place to cope with simultaneous severe accidents on several installations of the same site in the context of regional devastation resulting from a natural disaster
- keeping the schedule for the implementation of appropriate hardware measures
- generating a long term schedule, coping with the uncertainties related to the on-going investigations and analyses
- optimising the prioritisation between improvements already launched and new actions originating from lessons learned from Fukushima Dai-ichi accident
- enhancing international exchanges on research and solutions on molten core cooling and stabilisation (in/ex-vessel)
- dealing with large volumes of contaminated water
- assessing the role of contractors intervention in emergency situation and ensuring that the necessary arrangements for such interventions are in place
- Ensuring all aspects of installation safety (e.g. operational safety, safety culture) while performing ambitious programmes specifically originated from the Fukushima Dai-ichi accident is as well a key element in nuclear safety.

## **4. COUNTRY-BY-COUNTRY MAIN FINDINGS RESULTING FROM THE WORKSHOP**

In the following the workshop conclusions for all 17 countries that presented their NAcPs are provided.

### **Belgium**

Belgium gives comprehensive and understandable information in its National Action Plan (NAcP) related to further enhancing the safety of its nuclear power plants in the light of the Fukushima Daiichi accident. The NAcP is in compliance with the national stress tests, the results of the country visit within the ENSREG Peer Review, the recommendations and suggestions of ENSREG and to those of the extraordinary meeting of CNS.

The NAcP doesn't closely follow the structure proposed by ENSREG, though it covers all the required sources and the issues identified.

The transparency policy expected by ENSREG is satisfied by publishing all stress test related information on the webpage of the regulatory body.

Although the action plan of Belgium is being carried out without legally binding ordinances from the national regulator, the actions are being completed mainly as scheduled.

The majority of planned actions are to be implemented by the end of 2013, only 3 of them are planned to 2017 and the deadline of a handful of actions is not fixed yet.

Belgium has extended the stress test exercise to other nuclear installations than nuclear power plants which is considered as a good practice.

Regarding the filtered containment venting, the detailed design still needs to be defined. This could challenge the target date for implementation.

Belgium has elaborated a very detailed action plan in order to further improve the safety of its nuclear power plants. The implementation of this plan is closely monitored by the regulatory body.

### **Bulgaria**

Bulgaria gives comprehensive and understandable information on the improvement of safety of its NPPS in the light of the Fukushima Daiichi accident, in accordance to the national stress tests, to the recommendations and suggestions of ENSREG and to those of the CNS. In addition to the operating two NPP units, the spent fuel storage facilities are also covered by the action plan.

The NAcP closely follows the structure proposed by ENSREG with some specific interpretation of "Additional actions". Some of the actions referred in the NAcP are quite complex, actually covering several elementary actions.

The implementation of all actions is planned before the end of 2017. Several actions are already completed, the majority of actions are "in progress", and some are not started yet, but their completion date is scheduled. Internal milestones are not referred in the document.

Several good practices and experiences can be identified: The action to develop a programme to review the regulatory requirements by the end of 2013 in the light of the Fukushima Daiichi accident lessons learned; the plan to elaborate a probabilistic analysis to include the effects of extreme weather conditions on the KNPP site, according to the IAEA methodology and considering credible conditions of combinations, further the regular walk-downs to verify the conditions of the SAMG related premises and equipment.

The molten core handling for the VVER-1000 reactors is being analysed as an international effort and the solution for the problem can only be decided after the completion of these

analyses. The management of large volumes of radioactive water after a severe accident is also under investigation.

The Bulgarian action plan systematically covers all the items expected by ENSREG, outlining the situation in relation of every item and assigning action, whenever it is applicable.

## **Czech Republic**

The NAcP of the Czech Republic informs comprehensively and in an understandable manner how each NPP is improved in the aftermath of Fukushima according to national assessments, the recommendations and findings of the European Stress Tests and the conclusions of the CNS process.

The NAcP follows the structure proposed by ENSREG and covers actions specified in the ENSREG Action Plan. The implementation of improvement measures is clearly scheduled. .

The timeframe to implement the improvement measures is until end of 2017. In this regard a challenge remains in implementing measures for which the timeframe has been shortened after Fukushima compared with the original one.

The NAcP is accessible on the regulator's website currently only in English language. The conclusions of the interim inspections will be made public on the regulator's (SUJB) and licensee's (ČEZ, a.s.) websites.

A number of commendable practices are identified in the NAcP for example the extensive use of Periodic Safety Reviews to initiate further safety improvements as a precondition for further operation of NPPs. The NAcP is considered as a living document and is enforceable.

In some cases it was not clear to which extent the NAcP is covering the ENSREG recommendations and findings. These open issues were discussed and clarified during the national presentation.

A number of ENSREG recommendations are in an advanced stage of implementation. Some measures scheduled for long term were identified during the workshop as crucial ones, like analyses for maintaining the integrity of the containment and cooling of the molten core.

## **Finland**

The Finnish NAcP gives comprehensive and understandable information on the safety improvements of the Finnish nuclear power plants after the Fukushima accident, taking into account the national stress tests, the recommendations and suggestions of ENSREG and the CNS summary report. Finland followed the structure proposed in the ENSREG National plan.

The Finnish NAcP is published on the STUK website, together with other information and reports on post-Fukushima actions (including the Stress Tests).

Most planned actions and recommendations will be implemented by the end of 2014.

There are several actions implying studies or technical improvements. Resulting actions should be implemented by 2018.

Finland has adopted an approach of continuous improvement, utilizing the feedback of full scope Probabilistic Safety Assessments, including extreme weather conditions. Severe accident managements systems are required to be safety classified, qualified, independent and single failure tolerant.

Seismic safety assessments indicate that the retrofitting of all components and structures in existing plants to new seismic criteria is not necessary, but these criteria are taken into account for major modifications at the existing units and for new units.

Finland is planning several measures to improve core cooling. At Loviisa nuclear power plant, air cooled cooling units powered by an air-cooled diesel generator will be installed to ensure long term decay heat removal in case of loss of sea water. At Olkiluoto an independ-

ent way of pumping water based on the firefighting water system with additional booster pumps will be set up. Also steam driven pumps are considered for the early phases of the accident.

It was noted that Finland does not adopt the extended use of mobile means for accident management. Already existing fixed installed systems will be supplemented with some additional independent, diversified and protected fixed installed systems.

Finland remarked that the lessons from Fukushima are not the only safety concern and that the prioritisation of possible safety improvements is important in the sense of the desirable continuous improvement process.

## **France**

The structure of the French National Action Plan complies with the ENSREG Action Plan. The information supplied is adequate in general.

The tasks that France has defined address all recommendations, i.e. the general recommendations from the Peer Review, those specifically addressed to France, and the CNS recommendations. The measures defined are the basis for significant improvements of overall nuclear safety of French NPPs.

The NAcP and the process of implementation of the tasks are transparent. The state of progress of each task is presented in the report. The report is available on the regulator's website. The regulator will inform twice a year on the progress of implementation. Within the stress tests, representatives of the French High Committee for Transparency and Information on Nuclear Security, the local information committees and several foreign safety regulatory bodies were invited to attend the technical meetings as observers and to take part in the targeted inspections.

The approach of the hardened safety core is focused on beyond design basis events. Its objectives are prevention of an accident with fuel melt or limiting its progression, limiting large-scale radioactive releases and enabling the licensee to fulfill its emergency management duties. The safety core will include an additional ultimate electricity generating set for each reactor, a diverse emergency cool-down water supply for each reactor, new crisis management premises for each site, mobile devices and means of communication essential to emergency management, as well as technical and environmental instrumentation. They will be designed to withstand extreme natural hazards with references that are well beyond current design basis.

Decisions on the replacement of filtered containment venting will be taken after studies by the licensee that are to be completed by the end of 2013. The goal is mainly to improve filtration of iodine. This improvement should be considered with greater priority.

An offsite "rapid nuclear response force" is already operational and will be fully deployed for a four reactor site in 2014, with both mobile equipment and specialized crews which could intervene within 24 hours simultaneously on all units of an affected site.

The schedule of actions to be performed by the licensee covers the years 2012 to 2018. Taking into account that the concept of the hardened safety core will lead to substantial plant modifications and extensions, the time scale seems ambitious. Some of the tasks however, that are planned for the next Periodic Safety Review, will not be completed within this timeframe.

France extended the stress test to all of its 150 nuclear installations (58 NPPs, NPPs under construction, fuel cycle facilities, research reactors, etc.). As a result of this extended scope new waste storage facilities will be built. France also addresses social, organisational and human factors, which are key elements in safety. The regulator focuses on the renewal of the licensees' workforce and skills as well as the organisation of subcontracting, particularly the role of subcontractors in crisis management.

The tasks that France has defined allow significant improvements of overall nuclear safety of the French NPPs and they are mainly focused on preventive and mitigative accident management in case of extreme natural hazards. They will be designed with references that are well beyond current design basis.

## **Germany**

Germany's NAcP provides clear and comprehensive information on how the robustness of NPPs will be further reinforced in the aftermath of Fukushima according to the recommendations and suggestions of the European Stress Tests and the conclusions of the CNS process, although some of the activities are not easy to fully understand among the tables. The report is accessible on the internet in both English and German.

Many measures have already been completed at the NPPs, either after the Chernobyl accident (for example filtered containment venting, passive autocatalytic recombiners or nitrogen inertisation for BWRs, accident procedures such as primary and secondary feed and bleed), or in 2011/2012 (for example mobile diesel generator equipment). Some of the remaining identified activities and studies will be completed in 2013, with some left to be carried over to 2014/2015.

The German NAcP has identified that further work is ongoing in some technical areas which are relevant to the Stress Test. These have been generated by the Reactor Safety Commission (RSK), but no schedule is identified due to on-going consultations.

Germany could develop further its plans for reporting the completion and closure of the full scope of work identified as a result of the Stress Tests and the more general post-Fukushima activities identified nationally.

Germany's NPPs already included significant enhancements to robustness ahead of the Fukushima events and resulting Stress Test, including filtered containment venting and passive autocatalytic recombiners. The plans for further improvements, analysis, and studies are clear and comprehensive, but the plans for publishing the completion of the full scope of work identified as a result of the events at Fukushima could be developed further.

## **Hungary**

The Hungarian NAcP provides clear and comprehensive information on how the safety of their NPPs will be improved following the recommendations and suggestions of the European Stress Tests and the recommendations from the CNS. The structure of the Hungarian NAcP is compliant with the provided ENSREG guidance. The same applies for the content of the report which follows the ENSREG guidance very closely. The information provided in the NAcP is adequate and covers all aspects specified in the ENSREG Action Plan.

The NAcPs well as previous reports are accessible on the regulator's website.

The implementation of improvement measures is clearly scheduled with the specified timeframe to implement all the measures until the end of 2018.

A challenge for the authority is to verify that the external containment cooling solution is suitable to cope with the containment overpressurisation phenomena and that the modifications will not impair any existing safety functions and will satisfy the nuclear safety principles.

Hungary has fully integrated the IAEA nuclear safety fundamentals and standards as well as WENRA reference levels into the nuclear safety legislation.

## **Lithuania**

The Lithuanian NAcP informs comprehensively and well understandably on how the safety of the Ignalina NPP, which is shut down, and the spent fuel storage facilities, including all

spent nuclear fuel handling processes, in the country is going to be improved in the aftermath of Fukushima according to the national assessments, the recommendations and suggestions of the European Stress Tests and the conclusions of the CNS process.

The NAcP is transparent and accessible on the regulator's website.

The NAcP follows the structure of the ENSREG guidance. The items, that are relevant for Lithuania, which does not have operating nuclear power plants, are grouped in several subjects. Therefore it is not always clear how specific ENSREG recommendations and suggestions have been addressed.

The NAcP does not directly reply to comments related with the possible practical improvements of the spent fuel pools safety formulated by the Peer Review team in the Peer Review country report. During the workshop Lithuania provided explanations on this issue, as well as how other ENSREG recommendations and suggestions have been addressed.

Almost all actions will be *implemented* by the end 2013 or are already implemented. Most actions demand additional studies and assessments, several imply procedural revisions and review of regulations, while some demand hardware modifications, such as new measurement systems for the spent fuel pools.

The construction of a new nuclear power plant on the site of Visaginas is considered as a challenge for Lithuania. Lessons from Fukushima will be taken into account for this new unit.

## **Netherlands**

The Netherlands' NAcP informs comprehensively and well understandable on how the Borssele NPP in the Netherlands is about to implement various observations and conclusions according to the National assessments, the recommendations and suggestions of the European Stress Tests and the conclusions of the CNS process.

The NAcP follows the structure proposed by ENSREG and covers all aspects specified in the ENSREG Action Plan. An additional topic, in particular a decision that all licensees with nuclear installations other than NPP have to undertake a Complementary Safety Assessment (stress test) to assess the robustness of their facilities is added. This applied to waste management facilities, research reactors, nuclear research laboratories, and the enrichment plant. Among many other good practices a long term practice of Periodic Safety Reviews and a comprehensive practical use of Probabilistic Safety Assessments have been pointed out during the workshop discussion.

Within the frame of the ongoing Periodic Safety Review and the NAcP also the possibilities for in-vessel retention of molten core are investigated. Finding a solution constitutes a challenge, in view of the design characteristics of the Borssele NPP. It is suggested that the Netherlands takes note of progress made in this area in other countries and solutions already adopted.

The implementation of improvement measures is clearly scheduled. Progress will be reported by the licensee in three month intervals. The timeframe to implement all the improvement measures until end of 2016 is ambitious and commendable.

Regular information of Parliament as well as inclusion of the other nuclear facilities in the stress test exercise can be also seen as good practices.

## **Romania**

The NAcP informs comprehensively and well understandable how the NPP will be improved in the aftermath of Fukushima according to the National assessments, the recommendations and suggestions of the ENSREG Peer Reviews carried out after the Stress Tests, the conclusions of the CNS process and other sources.

The NAcP follows the structure proposed by ENSREG and covers all aspects specified in the ENSREG Action Plan, with some exceptions that were clarified during the workshop.

The NAcP – along with all EU stress test documents – is accessible on the regulator’s website in English language.

The implementation of improvement measures is clearly scheduled, and the ending date of the process (2015) is considered ambitious and commendable.

Romania considers the qualification of instrumentation and monitoring under severe accident conditions (especially in the long term) as a challenge. (ENSREG Recommendation 3.2.5)

During the workshop several other good practices have been identified in the NAcP. These are e.g. the construction of a new on-site emergency center, which is seismically robust and protected against external hazards as well as the development of a new off-site emergency control center located away from the site or the prompt implementation of relevant containment protection measures as passive autocatalytic recombiners and seismically qualified filtered venting.

## **Slovakia**

The NAcP follows the Structure proposed in the ENSREG Action Plan. It contains comprehensive information on the actions planned post-Fukushima, as well as on earlier safety improvements and measures.

The actions listed in the Slovak NAcP cover the ENSREG recommendations and the Country Peer Review recommendations.

A considerable part of the measures listed is in an advanced stage of implementation or concerns analyses, studies and planning further measures. There is a clear schedule for these measures. Depending on the outcome of analyses to be performed until 2015, the implementation of the technical and administrative findings will take place after 2015.

The correspondence between measures planned pre-Fukushima and post-Fukushima does not become entirely clear from the NAcP; however, this is a complex matter and some explanations have been provided at the Workshop.

It is a complex task to integrate these two categories and to generate a consistent overall schedule. Such a schedule has been developed reflecting both categories of measures. It should also be appreciated that a number of safety improvements was initiated long before the Fukushima accident as a result of the Periodic Safety Review, and the Stress Tests only confirmed that the right decisions had been taken.

Good practices could be identified in the NAcP, in particular in respect to the systematic use of Periodic Safety Reviews to identify improvement measures, the implementation of in-vessel retention which is already completed, and the application of a return frequency of  $10^{-4}$ /year for extreme weather events, as basis for the evaluation of safety important components and systems.

## **Slovenia**

The Slovenian NAcP informs comprehensively and in a transparent way how the safety of the Krško NPP is and will be improved in the aftermath of the Fukushima Daiichi accident, according to the national assessments, the recommendations and suggestions of the European stress tests and the conclusions of the CNS process.

The NAcP has been prepared by the Slovenian Nuclear Safety Administration (SNSA). The NAcP has followed the ENSREG guidance closely. The NAcP is structured in accordance with the structure suggested by ENSREG.

The English version of the NAcP is accessible on the website of SNSA.

During the ENSREG workshop in Brussels the Slovenian representatives gave further details on the Safety Upgrade Program of the Krško NPP and how each of the ENSREG recommendations is covered, as well as the expected time frame.



The identified measures will be implemented according to a three phase time schedule. The immediate actions after the Fukushima Daiichi accident were completed in 2012. Most of the measures which are part of the Safety Upgrade Program will be implemented in medium term till 2016. They comprise a wide range of technical measures, improvements or implementation of procedures and operational regulations, which are very well structured in a comprehensive program. The rest of the measures are scheduled until 2018, a number of them is at first subject to further analyses, on which basis further decisions will be made.

The use of a full scope simulator for severe accidents for the validation and training of SAMGs is a commendable practice in Slovenia.

Slovenia acted proactively after the Fukushima Daiichi accident and realized quite a lot of measures in the last two years. The incorporation of the IAEA action plan, the US-NRC recommendations and other (scientific) evaluation reports is as well a commendable practice.

## **Spain**

The NAcP informs comprehensively and in a well understandable way how the NPPs in Spain shall be improved in response to the lessons of the Fukushima accident, according to the National assessments, the recommendations and suggestions of the European Stress Tests and the conclusions of the CNS process and other sources.

The NAcP follows the structure proposed by ENSREG and covers all aspects specified in the ENSREG Action Plan. An important additional topic: potential loss of large areas at a NPP – which is at the interface between safety and security –also was addressed.

The NAcP – along with all EU stress test documents – is accessible on the regulator’s web-site.

At each site with nuclear power plants a “Local information Committee” is established to inform at least annually the local authorities, NGOs, and the general public about relevant aspects concerning the operation and any other topic which could be considered of interest in respect to the nuclear installations.

The implementation of improvement measures is clearly scheduled in three steps: short (until end of 2012), medium (until end of 2014) and long (until end of 2016).

Some of the actual modifications to be implemented are depending on the results of on-going analyses.

The timeframe to implement all the improvement measures until end of 2016 is ambitious and commendable. Nevertheless some measures scheduled for long term are crucial ones, like filtered venting and installation of PARs.

Several good practices could be identified in the NAcP of Spain, therein the issuance of specific Complementary Technical Instructions (ITCs) by the regulator; the maintenance of close co-operation between the regulator and the licensees to supervise the implementation of the action plan; the seismic margin analysis for 0.3 g, remote access to radiation data (including personnel dosimetry data) by bodies of emergency response organisation and the buildup of alternate on-site emergency centers and a nationwide emergency support center.

The significance of the periodic safety review (PSR) process – which is also a tool for periodic license renewal in Spain – is further enhanced with the inclusion of severe accident management in the review.

A challenge for Spain is the appropriate and timely implementation, in its regulation and practices, of the outcomes of the WENRA on-going review of the harmonisation of the reference levels in the field of external hazards.

Spain has prepared a convincing and effectively controlled action plan to establish a higher level of safety for its nuclear power plants in the light of the Fukushima lessons.

## Sweden

The NAcP follows the structure proposed in the ENSREG Action Plan. It contains comprehensive information on the actions planned in the aftermath of Fukushima, as well as background information on the European context of the activities and on the Swedish nuclear power plants.

The actions listed in the Swedish NAcP cover the ENSREG and Country Peer Review recommendations as well as CNS recommendations. However, there are no explicit references to the corresponding recommendations which would have been helpful for the review.

The NAcP mainly presents investigations for which the aim is to determine and consider which measures shall be implemented, and the time for their implementation. So far, there is a clear and relatively tight schedule for the activities. However, the subsequent implementation of the technical and administrative measures resulting from the investigations is a complex task which will constitute a challenge to generate an appropriate, comprehensive and consistent schedule for these measures. The final deadline provided for all related activities (2020) is later than most other countries. However, the implementation of the majority of the measures is expected before this year, but the definite deadlines cannot be provided before the investigations are completed. It is notable that the central spent fuel storage facility CLAB has been included in the stress test.

Specific safety goals in terms of timespans for keeping a safe plant state (e.g. in case of total loss of AC power) have been set in Sweden, which can be regarded as a good practice. It is also commendable that the implementation of severe accident management measures has begun in the 1980s and that Sweden applies continuous improvements and is implementing extensive modernisation programs.

The implementation of the independent core cooling systems should be considered with high priority and will be regarded as a challenge.

## Switzerland

Switzerland's NAcP provides clear and comprehensive information on how the safety of their NPPs will be improved following the recommendations and suggestions of the European Stress Tests and the conclusions of the CNS process. The NAcP follows the structure proposed by ENSREG and covers all aspects specified in the ENSREG Action Plan.

Many improvement measures have already been completed; most notably the national store of accident management equipment at Reitnau was ready by June 2011. The work described in the NAcP will be complete mainly in 2015. Because of some major backfitting projects related to additional requirements for long term operation (special topic of the 4<sup>th</sup> periodic safety review), the full implementation is expected by 2017. Many other activities will be complete sooner, but some limited improvement activities in the National Action Plan do not clearly identify completion timescales, as the scope of the measures require further analysis. The detailed schedule is updated annually and published in the Swiss regulator's report titled "Action Plan Fukushima", this and the NAcP are accessible from the Swiss regulator's website.

Several commendable practices were identified, including the development of the national accident management equipment store at Reitnau, the multi-agency review organisation (IDA NOMEX), all NPPs having 7 layers of AC power generation, and the implementation of the complex seismic hazard re-evaluation project PEGASOS.

The issue reported in the NAcP of whether restoring containment integrity during shutdown in the case of a total Station Black Out represents a time-critical measure may need further emphasis by the Swiss regulator ENSI.

Nuclear safety is a process of continuous improvement enshrined in the Swiss law. Switzerland has made significant safety improvements following Fukushima and has a clear planning and reporting structure which will confirm when the remaining work is complete, currently expected to be 2017.

## **Ukraine**

The Ukrainian NAcP informs in a transparent way on how NPPs in Ukraine are improved in the aftermath of Fukushima according to the National assessments, the recommendations and suggestions of the European Stress Tests and the conclusions of the CNS process.

The NAcP follows the structure proposed by ENSREG and covers all aspects specified in the ENSREG Action Plan. Additional topics related to the specific recommendations of the Peer Review of Stress Tests for Ukrainian NPPs and Safety Improvement Measures at Chernobyl NPP were reported.

The NAcP has been discussed and agreed at the open Board meeting of the national regulator, stakeholders including non-government organisations and media have been involved. The compliance with the schedule is a licensing condition and regularly monitored by the regulator. The Periodic Safety Review is used to verify the compliance with the licensing conditions and to identify additional measures if necessary.

A number of safety improving measures were defined before the Fukushima event and are subject to the on-going Comprehensive (Integrated) Safety Improvement Program (for operating plants) and under the “Safety Improvement Plan for Chernobyl NPP Nuclear Installations”. The scope and priorities of these measures were revised with due consideration of their relevance in the light of the Fukushima accident.

As regards filtered venting Ukraine already approved this measure for VVER-1000 units just after Fukushima. The relevance for VVER-440 units is subject to further analysis.

In some cases it was not clear to which extent the NAcP is covering all ENSREG recommendations/findings. These open issues have been discussed and clarified during the workshop.

An interesting aspect is that a measure is first implemented in a pilot power plant unit with reactors of each design and afterwards in other units taking into account the experience gained from the pilot NPP.

## **United Kingdom**

The UK NAcP gives comprehensive and understandable information on the safety improvements of the UK nuclear power plants after Fukushima, taking into account the national stress tests, the recommendations and suggestions of ENSREG and the CNS summary report.

The NAcP closely follows the structure proposed by ENSREG. The following additional topics are addressed: planning controls, safety assessment approach, research, spent fuel strategies and human capabilities and capacities.

The UK’s national action plan is published on the ONR website, along with an implementation report and other relevant documents. Additionally, the UK has included recommendations to improve openness and transparency.

All planned actions will be implemented by the end of 2014, with a majority planned for 2013, which is a very tight schedule.

Most actions are studies, assessments or reviews, further modifications may result from these. No major design modifications currently arise from the studies, besides from the filtered containment venting, which is currently under consideration. Soon after the Fukushima accident, additional back-up equipment was purchased and passive autocatalytic recombiners are being installed at Sizewell B in April 2013.

For the Wylfa Magnox reactor actions were taken to realise safety benefits with short implementation times, noting that extended actions would surpass the remaining life time.

The UK has defined several actions regarding emergency preparedness, including a future exercise program to test on-site, off-site and central government responses for prolonged periods and the large scale multi-unit exercise, which is planned for spring 2014.

Methodologies for the re-evaluation of hazards margins to confirm the absence of cliff edges remains a topic of discussion.

Another addition to the emergency preparedness is the availability of multi-use modular accommodation and command units and other emergency back-up equipment in dedicated strategic depots, with the associated 20-year specialist maintenance contracts that assure operability in emergency situations, which is considered a good practice.

## 5. ANNEXES

### List of acronyms

AC	Alternating Current
BWR	Boiling Water Reactor
ČEZ a.s.	České Energetické Závody (Czech Republic)
CLAB	Centralt mellanlager för använt kärnbränsle (Sweden)
CNS	Convention on Nuclear Safety
DC	Direct Current
EC	European Commission
ENSI	Eidgenössisches Nuklearsicherheitsinspektorat (Switzerland)
ENSREG	European Nuclear Safety Regulators Group
EU	European Union
IAEA	International Atomic Energy Agency
IRRS	Integrated Regulatory Review Service
ITC	Complementary Technical Instructions
IVR	In Vessel Retention
KNPP	Kozloduy Nuclear Power Plant (Bulgaria)
LWR	Light Water Reactor
NAcP	National Action Plan
NGO	Non-Governmental Organisation
NPP	Nuclear Power Plant
NRC	Nuclear Regulatory Commission (US)
ONR	Office for Nuclear Regulation (UK)
OSART	Operational Safety Review Team
PAR	Passive Autocatalytic Recombiner
PSA	Probabilistic Safety Analysis
PSR	Periodic Safety Review
PWR	Pressurized Water Reactor
RSK	Reaktorsicherheits-Kommission (Germany)
SA(M)(G)	Severe Accident (Management) (Guidelines)
SNSA	Slovenian Nuclear Safety Administration
STUK	Säteilyturvakeskus (Finland)
SÚJB	Státní úřad pro jadernou bezpečnost (Czech Republic)
VVER	Vodo-Vodyanoi Energetichesky Reactor
WANO	World Association of Nuclear Operators
WENRA	Western European Nuclear Regulators' Association

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In addition 31 experts participated for their related country presentations only.

