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EU STRESS TEST
SWISS NATIONAL ACTION PLAN
FOLLOW UP OF THE PEER REVIEW
DECEMBER 2014

EU Stress Test: Swiss National Action Plan

Follow up of the Peer Review

December 2014

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Introduction

In the aftermath of the Fukushima Dai-ichi accident the international community has undertaken several actions to foster exchange of information, cooperation and peer review in the field of nuclear safety, thus facilitating the leverage and dissemination of the lessons learned from the accident.

In September 2011 the International Atomic Energy Agency (IAEA) issued the so-called Action Plan on Nuclear Safety /1/ addressing issues that the international community as well as the single member countries should adhere to with the ultimate goal of strengthening nuclear safety worldwide. The IAEA decided also to call for a (second) extraordinary meeting of the contracting parties to the Convention on Nuclear Safety (CNS), which was held in August 2012 and resulted in a list of action-oriented objectives compiled in the annex to the Final Summary Report of the meeting /2/.

In parallel, the European Council mandated the European Nuclear Safety Regulators Group (ENSREG) to conduct a first-of-a-kind peer review exercise for nuclear power plants in Europe – the European Stress Tests – addressing the targeted re-evaluation of safety margins in relation to the most relevant Fukushima issues. The European Stress Tests were concluded in April 2012 /3/ and a follow-up was launched to monitor the advancement of post-Fukushima activities on the considered topics. In the frame of the follow-up activities, ENSREG produced a compilation of recommendations and suggestions /4/ summarizing the results and best practices identified during the peer review of the 17 country reports participating in the exercise (15 countries from the European Union (EU) having nuclear power plants plus Switzerland and Ukraine).

The Swiss Federal Nuclear Safety Inspectorate (ENSI), as regulatory authority for nuclear safety and security in Switzerland, has actively contributed to the above-mentioned international efforts with the conviction that efforts towards more transparency and openness benefit the internationally shared fundamental safety objective /5/ of protecting people and the environment from harmful effects of ionizing radiation. Thus ENSI submitted several reports to international scrutiny and discussion, among which should be mentioned: the Swiss National Report for the European Stress Tests /6/ with the corresponding Peer Review report by ENSREG for Switzerland /7/, the Swiss status report for 2012 within the frame of the European Stress Tests Follow-Up /8/ with the corresponding Peer Review Summary report by ENSREG /9/. Along the lines of the IAEA Action Plan on Nuclear Safety, ENSI has published the following reports: Swiss National Report to the Second CNS Extraordinary Meeting in 2012 /10/ and the 6th National Report of Switzerland to the Convention on Nuclear Safety in 2013 /11/. Beyond that, ENSI hosted at the end of 2011 an Integrated Regulatory Review Service (IRRS) Mission of the IAEA, a peer review mission on the activities of the regulatory body, the results of which were made publicly available /12/. At the same time, as recommended in the IAEA Action Plan, the Mühleberg NPP invited an Operational Safety Review Team (OSART) led by the IAEA to conduct a peer review mission on its operational activities and disclosed the mission's results /13/. The follow-up OSART Mission in Mühleberg NPP took place in June 2014 and the corresponding report was recently released /14/. The follow-up IRRS mission for ENSI will take place in 2015.

At the national level ENSI conducted in 2011 an event analysis aiming at extracting the lessons learned in view of their applicability for the situation in Switzerland and derived from those a series of so-called checkpoints (referred to as PP and OP in the text) which warranted further analysis /15/. In response to the Country Peer Review for Switzerland which took place in March 2012, further open points (referred as PRT in the text) were added to the issue list (see Tables 7.1 and 7.2 of the present report). In order to keep track of the work conducted on the identified issues, ENSI publishes the Action Plan Fukushima on a yearly basis (/16/, /17/, /18/).

In April 2012 the EU Stress Test Peer Review Final Report /3/ was accepted in a joint ENSREG/European Commission (EC) statement and it was agreed that an ENSREG action plan would be developed to track the imple-

mentation of the recommendations. As part of the ENSREG action plan each national regulator had to generate a country-specific action plan. A first version of this National Action Plan (NAcP) was delivered at the end of 2012 followed by a workshop to review the NAcP in 2013. In this context, a rapporteur's report was elaborated for each country together with the summary report from the workshop /9/. In 2014 ENSREG decided for an update of the NAcP by the end of the year and asked the participants to include in their updates the following information:

- Response/clarification on any issues identified in the rapporteur's report from the 2013 workshop.
- Progress on implementation and update of the NAcP.
- Main changes in the NAcP since the 2013 workshop with justification, including:
  - additional measures
  - measures removed or modified
  - changes in the schedule
- Technical basis leading to the main changes identified in the NAcPs.
- Relevant outcomes of studies and analyses identified in the NAcPs, and completed since the 2013 workshop.
- Nationally identified good practices and challenges during implementation so far.

The present report describes the implementation status in Switzerland of the recommendations issued by ENSREG and the 2nd extraordinary meeting of the IAEA Convention on Nuclear Safety as of December 2014. It was compiled in line with the ENSREG instructions and represents the Swiss National Action Plan (NAcP) regarding the Follow-Up of the European Stress Tests as of December 2014.

Parts I lists the ENSREG recommendations one by one related to topics 1 to 3. Part II lists the CNS recommendations formulated during the 2nd Extraordinary Meeting (CNS EOM), extracted from /2/ and /4/ in their original formulation. The concerned chapters include a concise comment about how Switzerland, and in particular ENSI, has dealt with the issue. It should be noted that the recommendations from the 2nd CNS Extraordinary Meeting mainly deal with those topics to be reported about within the frame of the CNS. The present National Action Plan hence summarizes the information presented in the 6th CNS report of Switzerland which was published in 2013 /11/. Reference is also made to the ENSI analysis on lessons learned, checkpoints and open points as summarized in Part III. Part IV consists of two tables cross-referencing ENSREG and CNS EOM recommendations with the corresponding ENSI PP, OP and PRT.

Further details on the foreseen actions will be presented in the ENSI Fukushima Action Plan 2015 to be published in German in February 2015.

Legend

ENSREG recommendation number: description

CNS 2nd extraordinary meeting recommendation number: description

PP Checkpoint number
OP Open Point number
PRT Peer Review Team number

Part I: Implementation of the ENSREG recommendations derived from the Post-Fukushima Stress Tests conducted in the European Union (areas 1-3)

0 European Level Recommendations

0.1 European guidance on assessment of natural hazards and margins

***ENSREG recommendation 2.1**: Overall, the compliance of the European stress tests with the ENSREG specification was good with regard to compliance of the installations with their design basis for earthquake and flooding. However there was a lack of consistency identified with respect to natural hazards assessments where significant differences exist in national approaches and where difficulties were encountered with beyond design margins and cliff-edge effects assessments. Therefore: 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.*

PP1
OP4-1

In compliance with the Swiss Department of Environment, Transport, Energy and Communication (DETEC) Ordinance on the Hazard Assumptions and the Assessment of the Protection against Accidents in Nuclear Installations, hazard assumptions are regularly updated to take into consideration findings from operating experience, research and other methodological developments. In particular with the PEGASOS Project and the PEGASOS Refinement Project (PRP), Switzerland has performed a first-of-a-kind study in Europe for the probabilistic assessment of seismic hazards on the sites of the Swiss NPPs.

As regards most recent regulatory developments, ENSI is an active contributor in the Western European Nuclear Safety Regulators Association (WENRA) Reactor Harmonisation Working Group (RHWG) and its subgroup on natural hazards assumptions. The WENRA revised Safety Reference Levels were published in September 2014 /19/ and will be included in the regulation by ENSI.

0.2 Periodic Safety Review

***ENSREG recommendation 2.2**: The peer review demonstrated the positive contribution of periodic safety reviews as an efficient tool to maintain and improve the safety and robustness of plants. In the context of the peer review, this finding is especially relevant for the protection of installations against natural hazards. Therefore: 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.*

In Switzerland, Periodic Safety Reviews (PSRs) are mandatory. As stated in the Article 34 of the Swiss Nuclear Energy Ordinance (NEO), the following elements are part of a PSR:

- safety concept
- operational management and performance
- deterministic safety analysis
- probabilistic safety analysis
- overall safety assessment
- organisation and personnel

The deterministic and probabilistic analyses must be based on up-to-date hazard assumptions.

In the course of 2014 ENSI has replaced an old guide by issuing a new regulatory guideline ENSI-A03 "Periodic Safety Review of Nuclear Power Plants", which includes detailed requirements on the content of periodic safety reviews and their documentation. The guideline was drafted also in line with the IAEA Safety Standards on PSRs.

0.3 Containment integrity

***ENSREG recommendation 2.3**: The Fukushima disaster highlighted once again the importance of the containment function, which is critical, as the last barrier to protect the people and the environment against radioactive releases resulting from a nuclear accident. This issue was already extensively considered, as a follow-up of previous accidents, and possible improvements were identified. Their expeditious implementation appears to be a crucial issue in light of Fukushima accident. Therefore: Urgent implementation of the recognised measures to protect containment integrity is a finding of the peer review that national regulators should consider. The measures to be taken can vary depending on the design of the plants. For water cooled reactors, they include equipment, procedures and accident management guidelines to:*

- *depressurize the primary circuit in order to prevent high-pressure core melt;*
- *prevent hydrogen explosions;*
- *prevent containment overpressure.*

PP5 / PP7 / PP8
OP6-2

In Switzerland, ENSREG recommendation 2.3 has already been analysed and technical measures have been implemented to protect the third barrier. Regarding hydrogen hazards, extensive studies had been performed in the past which served as basis for the probabilistic safety analyses. ENSI nevertheless ordered a new re-assessment of this topic also taking into account the state-of-the-art in backfitting technology. As listed in the Action Plan Fukushima 2013 /17/, the following plant-specific points were addressed:

- review of robustness and scope of the measurement equipment in connection with the assessment of the hydrogen hazard;
- update of the hydrogen hazard analyses as well as investigation of hydrogen dispersion from the containment to other buildings;
- review of existing provisions and procedures for protection against the hydrogen hazard;
- review of the containment venting path with regard to the hydrogen hazard.

2014: The licensees submitted the requested studies on hydrogen mitigation in the containment and in other buildings. Within this project, a review of the corresponding hydrogen measurements was conducted too.

Some licensees proposed to equip their containment with Passive Autocatalytic Recombiners (PARs). ENSI's review of all these studies is ongoing. Preliminary results seem to confirm the need of backfitting measures in those NPPs without inertization. Further updates of the plant-specific SAMGs may be required to complement the hardware implementation.

The restoration of the containment integrity in case of a total Station Black-Out (SBO) during shutdown (see OP6-2) has also been identified as an open point by ENSI at the end of the EU stress tests. In fact, fairly large containment openings are present for a specified period during shutdowns in connection with the annual refuelling and maintenance outages in order to transport material and equipment or to allow access by individuals. If an accident involving a prolonged loss of the power supply (SBO) occurs during this period, it must be expected that the restoration of containment integrity will have to be carried out under more difficult conditions. At the end of the first EU Stress Tests Follow-Up workshop in April 2013, ENSI was also suggested to put additional emphasis on this issue. Specifications for the analyses to be performed by the operators were issued at the end of 2013. The operators submitted the related studies in October 2014. These reports are currently under review.

0.4 Prevention of accidents resulting from natural hazards and limiting their consequences

***ENSREG recommendation 2.4**: The Fukushima disaster has also shown that defence-in-depth should be strengthened by taking into account severe accidents resulting from extreme natural hazards exceeding the levels taken into account by the design basis and current safety requirements applicable to the plants. Such situations can result in devastation and isolation of the site, an event of long duration, unavailability of numerous safety systems, simultaneous accidents of several plants including their spent fuel pools, and the presence of radioactive releases. Therefore: 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. Typical measures which can be considered are bunkered equipment to prevent and manage severe accident including instrumentation and communication means, mobile equipment protected against extreme natural hazards, emergency response centres protected against extreme natural hazards and contamination, rescue teams and equipment rapidly available to support local operators in long duration events.*

All PPs
All OPs
All PRTs

2011: The results of ENSI's reviews performed after Fukushima confirmed that the Swiss NPPs display high levels of protection against the impacts of earthquakes, flooding and combinations thereof, and that appropriate precautions have been put in place to cope with a loss of power supply and of the ultimate heat sink. For such events, the legal requirements are met, taking into account the latest hazard assumptions and the NPPs are therefore in compliance with the safety objectives.

Beyond that, with regard to reactivity control, fuel cooling and confinement of radioactive substances, safety margins are available. During the evaluation of the safety margins, the importance of the bunkered special emergency safety systems in place in the Swiss NPPs was confirmed.

2013: As described in the ENSI Fukushima Action Plan 2013 /17/, a project was started with the aim of increasing the safety margins. Based on the results of the deterministic and probabilistic analyses, areas for possible significant risk reduction had to be identified by the operators.

2014: The operators submitted their relevant studies for earthquakes and external flooding. ENSI's review of these studies will be done by the end of the year. Depending on the results of the review, ENSI will consider to request further improvements to enhance safety margins.

1 Natural hazards

1.1 Hazard Frequency

ENSREG recommendation 3.1.1: The use a return frequency of 10^{-4} per annum (0.1g minimum peak ground acceleration for earthquakes) for plant reviews/back-fitting with respect to external hazards safety cases.

PP1

2011: In the aftermath of Fukushima ENSI ordered the seismic safety of the Swiss NPPs to be reassessed. In the analysis, the operators had to consider the intermediate results of the PEGASOS Refinement Project (PRP) for the site-specific seismic hazard (return frequency 1E-4/y as required in the Swiss regulations).

2012: The analyses showed that the Swiss NPPs can withstand natural hazards with a return frequency of 1E-4/y, with only moderate, non-safety relevant building damage, and have further margins beyond this.

2013: The PRP results were submitted to ENSI for final review following the Senior Seismic Hazard Analysis Committee (SSHAC) Level 4 procedure followed for the evaluation of the seismic hazard.

2014: ENSI is reviewing the submitted documents. Depending on the outcome of the review a renewed seismic safety assessment by the operators may be required.

1.2 Secondary Effects of Earthquakes

ENSREG recommendation 3.1.2: The possible secondary effects of seismic events, such as flood or fire arising as a result of the event, in future assessments.

PP1

In the Swiss legislative framework, the DETEC ordinance on the Hazard Assumptions and the Assessment of the Protection against Accidents in Nuclear Installations requires that secondary effects of earthquakes be considered in the seismic safety cases.

2011: ENSI ordered the seismic safety of the Swiss NPPs to be reassessed.

2012: ENSI confirmed that the seismic safety cases of the Swiss NPPs are compliant with the relevant requirements.

2013: The Mühleberg NPP started a project for reinforcing the Wohlen Lake dam (some 2 Km upstream from the Mühleberg NPP) against sliding, in order to further decrease the hazard of seismically-induced flooding. Licensing authority for the project is the Swiss Federal Office of Energy (SFOE) (supervision of dams).

2014: The project for the reinforcement of the Wohlen Lake dam was completed, which significantly increased the seismic capacity of the installation.

1.3 Protected Volume Approach

ENSREG recommendation 3.1.3: The use of a protected volume approach to demonstrate flood protection for identified rooms or spaces.

PP4

The reactor buildings and the buildings with the bunkered safety systems of all Swiss NPPs are protected against flooding.

2011-2012: The flood protection of some other safety-relevant buildings was enhanced with mobile flood barriers to ensure dry plant areas for safety relevant systems for even higher flood levels after the re-evaluation of risks.

2014: The Mühleberg NPP started a project for reinforcing flooding protection of an additional water intake on the Aare river by building a new pump station on an elevated location. The implementation is still ongoing.

1.4 Early Warning Notifications

ENSREG recommendation 3.1.4: 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.

PP1
OP4-1

Warning systems are already in place for rivers, dams and similar facilities with the potential to cause flooding at NPP sites in case of large releases of water or extreme weather conditions. Corresponding procedures exist on the NPP operator's side, e.g. for the installation of additional flood protection measures in the case of early warnings.

2012: ENSI requested the safety cases for extreme weather conditions to be updated by the operators.

2014: The updated hazards for extreme weather conditions were submitted at the beginning of the year and safety cases will be submitted to ENSI by the end of the year. Changes in the procedures or technical specifications, if necessary, will be part of the evaluation.

The installation of the mentioned additional measures e.g. against flood has been trained in drills.

1.5 Seismic Monitoring

ENSREG recommendation 3.1.5: The installation of seismic monitoring systems with related procedures and training.

PP1 / PP5
OP2-1

At all four Swiss NPP sites, seismic monitoring systems were installed many years before the Fukushima accident. Operating procedures include rules for the operators on how to respond after certain pre-defined seismic thresholds are reached, e.g., Operating Basis Earthquake (OBE) and Safe Shutdown Earthquake (SSE).

2014: ENSI is analysing the advantages and disadvantages of an automatic shutdown of the plants triggered by the seismic instrumentation. Depending on the results of the analysis, upgrades could be initiated.

1.6 Qualified Walkdowns

ENSREG recommendation 3.1.6: 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).

PP4

Guideline ENSI-A05 requires systematic and comprehensive walkdowns in the context of the development and update of a Probabilistic Safety Assessment (PSA) based on recognised standards, e.g. for seismic walkdowns EPRI-NP-6041-SL.

All the NPPs have developed seismic housekeeping concepts which are regularly inspected by ENSI.

1.7 Flooding Margin Assessments

ENSREG recommendation 3.1.7: 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.

PP1 / PP4

2011: The external flooding analyses were redone for flood levels with an exceedance frequency of 1E-4 per annum. It could be shown that all Swiss NPPs fulfil the regulatory requirements.

2012: A research project was initiated in Switzerland to develop the scientific data necessary to further refine the flood hazard assessment.

2013: ENSI started a project with the aim of increasing the safety margins in case of accidents beyond the design basis (including seismic and external flooding events).

2014: The operators' reports on increasing the safety margins regarding external flooding were submitted to ENSI and are under review. Depending on the results of the review, ENSI will consider demanding further improvements to enhance safety margins.

1.8 External Hazard Margins

ENSREG recommendation 3.1.8: The formal assessment of margins for all external hazards including, seismic, flooding and severe weather, and identification of potential improvements.

PP1
OP2-2
PRT-1

2011: The external flooding analyses were redone for flood levels with an exceedance frequency of 1E-4 per annum. It could be shown that all Swiss NPPs fulfil the regulatory requirements.

2012: A project with several federal agencies was initiated in Switzerland to develop the scientific data necessary to further refine the flood hazard assessment.

2013: ENSI started a project with the aim of increasing the safety margins in case of accidents beyond the design basis (including seismic and external flooding events).

2014: The operators' reports on increasing the safety margins regarding external flooding were submitted to ENSI and are under review. Depending on the results of the review, ENSI will consider to demand further improvements to enhance safety margins.

2 Loss of safety systems

2.1 Alternate Cooling and Heat Sink

ENSREG recommendation 3.2.1: The provision of alternative means of cooling including alternate heat sinks. Examples include steam generator (SG) gravity alternative feeding, alternate tanks or wells on the site, air-cooled cooling towers or water sources in the vicinity (reservoir, lakes, etc.) as an additional way of enabling core cooling.

PP3 / PP12 / PP13 / PP14

All Swiss NPPs with the exception of the Mühleberg NPP have redundant, diverse ultimate heat sinks.

2011: At ENSI's request the Mühleberg NPP started a project to backfit an additional, diverse ultimate heat sink.

2012: ENSI approved the Mühleberg NPP's submittal issuing the so-called permit of concept.

2013: The Mühleberg NPP decided to permanently shutdown the plant in 2019 and informed ENSI about its intention of abandoning the approved concept.

2014: The Mühleberg NPP submitted a proposal of alternative measures for a diverse ultimate heat sink taking into account its limited remaining operating lifetime. In its evaluation (currently in draft form) ENSI approved the proposed concept for the diverse ultimate heat sink, which has to be implemented by the Mühleberg NPP by 2015.

2.2 AC Power Supplies

ENSREG recommendation 3.2.2: The enhancement of the on-site and off-site power supplies. Examples include adding layers of emergency power, adding independent and dedicated backup sources, the enhancement of the grid through agreements with the grid operator on rapid restoration of off-site power, additional and/or reinforced off-site power connections, arrangements for black start of co-located or nearby gas or hydro plants, replacing standard ceramic based items with plastic or other material that are more resistant to a seismic event. Another example is the possible utilisation of generator load shedding and house load operation for increased robustness, however, before introducing such arrangements the risks need to be properly understood.

PP2 / PP13

The design of power supply of the Swiss NPPs is based on multiple layers of defence. The first layer consists of the external main grid; the second layer consists of the island mode of the plant after load rejection (failure of the main grid). The external reserve grid acts as third layer. The emergency electrical power supply (either from an emergency Diesel Generator (DG) or a direct feed from a hydroelectric power plant) is the fourth layer. In the fifth layer the special emergency electrical power supply from bunkered emergency DGs is activated upon loss of external feed. A sixth layer consists of accident management equipment.

Since the Fukushima event, the sixth layer has been reinforced and a seventh layer with off-site accident management equipment has been newly added (see ENSREG recommendation 3.3.14). As the supply of Alternating Current (AC) power to the Swiss NPPs is highly reliable, no further actions are foreseen to enhance the AC power supplies.

2.3 DC Power Supplies

ENSREG recommendation 3.2.3: The enhancement of the DC power supply. Examples include improving the battery discharge time by upgrading the existing battery, changing/diversifying battery type (increasing resistance to common-mode failures), providing spare/replacement batteries, implementing well-prepared load-shedding/ staggering strategies, performing real load testing and on-line monitoring of the status of the batteries and preparing dedicated recharging options (e. g. using portable generators).

PP2
OP5-1

All battery groups for safety-important electrical loads in an emergency have been analysed with respect to the battery discharge time and their locations in the buildings. The result showed that, for safety equipment, battery life – before accident management power supply for recharging the batteries is available – is sufficient in all cases, and for safety-important equipment in most cases.

ENSI's requirements regarding Direct Current (DC) power supply is a minimum battery capacity of 4 hours, allowing to connect accident management supplies for charging the batteries during this timeframe. Furthermore, the battery capacity will be checked when planning any change of the loads and before replacement (e.g. because of ageing).

2.4 Operational and Preparatory Actions

ENSREG recommendation 3.2.4: Implementation of operational or preparatory actions with respect to the availability of operational consumables. Examples include, ensuring the supply of consumables such as fuel, lubrication oil, and water and ensuring adequate equipment, procedures, surveillance, drills and arrangements for the resupply from off-site are in place.

PP2 / PP12 / PP13

2011: creation of an external earthquake- and flood-proof storage facility at Reitnau, containing various accident management provisions for emergencies including DG fuel and other consumables. Enhancement of the equipment on site was also conducted by the operators.

2012: ENSI reviewed the operational concept of the Reitnau external storage facility and inspected it.

2013: The procedures of the activation of the Reitnau external storage facility and the provision of Severe Accident Management (SAM) equipment and its transportation from the external storage facility to the plants have been tested. These tests have been carried out as part of an unannounced alarm exercise in one NPP and a national emergency drill.

Other drills have been executed, to test the transport of equipment to the site by helicopter, simulating severe damage at the site making access by roads unusable. The external storage facility in Reitnau was commended by an OSART follow-up mission for Mühleberg NPP in 2014 as a good practice.

2014: The evaluation of the integration of Reitnau in the procedural guidance for emergencies started.

2.5 Instrumentation and Monitoring

ENSREG recommendations 3.2.5: The enhancement of instrumentation and monitoring. Examples include separate instrumentation and/or power sources to enable monitoring of essential parameters under any circumstances for accident management and the ability to measure specific important parameters based on passive and simple principles.

PP5

Guideline ENSI-B12 on emergency preparedness sets the requirements for accident instrumentation and monitoring.

2011-2014: Upon ENSI's request the NPPs backfitted new temperature and level measurements for the Spent Fuel Pools (SFPs). The older NPPs also started major backfitting projects for an additional flooding and seismically robust SFP cooling system.

2014: new analyses on hydrogen management have been submitted by the operators and are currently being reviewed by ENSI (for first results, see also ENSREG recommendation 2.3). Within this project, a review of the corresponding hydrogen measurements was conducted.

2.6 Shutdown Improvements

ENSREG recommendation 3.2.6: The enhancement of safety in shutdown states and mid-loop operation. Examples of improvements include, reducing or prohibiting mid-loop operation, adding dedicated hardware, procedures and drills, the use of other available water sources (e. g. from hydro-accumulators), requiring the availability of SGs during shutdown operations and the availability of feedwater in all modes.

The Swiss NPPs have sufficient procedures on the required availability of core cooling capacity in shutdown states and mid-loop operation.

2.7 Reactor Coolant Pump Seals

ENSREG recommendation 3.2.7: The use of temperature-resistant (leak-proof) primary pump seals.

PP3

Gösgen NPP, Leibstadt NPP and Mühleberg NPP all have primary pumps that are inherently leak-proof after shutdown.

2014: the Beznau NPP plans to install an additional robust seal water system as part of its bunkered special emergency system. This backfitting will be implemented during the 2015 outage.

2.8 Ventilation

ENSREG recommendation 3.2.8: The enhancement of ventilation capacity during SBO to ensure equipment operability.

PP2

Effects of the loss of ventilation at the special emergency control rooms were tested. These tests showed that the operability of the equipment located in rooms of the special emergency bunkered systems, including control panels, is assured for at least several days.

During an extended SBO the necessary safety functions will be carried out by means of accident management measures (AMM), e.g. the use of fire water pumps or trucks, mobile diesel generators, and other means that have a relatively small waste heat production compared to the regular safety systems. According to ENSI's experience, conduction of AMM is possible without extra ventilation of such equipment.

2.9 Main and Emergency Control Rooms

ENSREG recommendation 3.2.9: 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).

PP10 / PP11

Since 1996 improvements of the ventilation of the main control room (MCR) were implemented in order to ensure the habitability of the MCR in case of accidents with release of radioactive material. The special emergency control room displays were extended by adding neutron flux, important containment data, and stack release parameters to the existing displays. Further enhancements were carried out regarding operational safety and availability.

2012: a review of the emergency infrastructure at the NPPs site was initiated. The inspections that took place focused on short term operability of the ECCs and their substitute rooms: topics addressed encompass the operation strategy of the ECCs and their substitute rooms as well as single aspects of their habitability under severe accident conditions. The operators have also been required to submit reports on the long term operability of these rooms.

2013: Follow-up inspections were carried out, focusing on the radiation protection material to be used in case of an emergency.

2014: ENSI has reviewed the submitted reports on the long term operability of the ECCs and their substitute rooms. This review underlined the importance of an off-site ECC-facility as an alternative to the protected infrastructure on-site and ENSI is requesting that the operators follow-up on this issue expanding their existing concepts for ECCs.

2.10 Spent Fuel Pool

ENSREG recommendation 3.2.10: The improvement of the robustness of the spent fuel pool (SFP). Examples include reassessment/upgrading SFP structural integrity, installation of qualified and power-independent monitoring, provisions for redundant and diverse sources of additional coolant resistant to external hazards (with procedures and drills), design of pools that prevents drainage, the use of racks made of borated steel to enable cooling with fresh (unborated) water without having to worry about possible recriticality, redundant and independent SFP cooling systems, provision for additional heat exchangers (e. g. submerged in the SFP), an external connection for refilling of the SFP (to reduce the need for an approach linked to high doses in the event of the water falling to a very low level) and the possibility of venting steam in a case of boiling in the SFP.

PP6 / PP14

2011: the protection of the Swiss NPPs and their Spent Fuel Pools (SFP) against external events has been reassessed by the operators and reviewed by ENSI.

ENSI ordered all licence holders to immediately implement two physically separated lines/connections for feeding the SFPs from outside the buildings as an accident management measure, and to backfit seismically

robust SFP cooling systems in the older NPPs. Correspondingly, backfitting projects are ongoing at the Beznau and Mühleberg NPPs.

The Beznau NPP is furthermore required to improve the earthquake resistance of the SFP storage building, and has to implement a venting duct to remove heat and pressure generated by boiling SFP water in order to protect the building structure in case of beyond design basis accidents. A backfitting project was launched in this respect and was foreseen to be completed by 2014. Because of other major backfitting measures started before Fukushima as well as some difficulties in the procurement of the necessary nuclear-grade components, this project is delayed. ENSI accepted a final postponement until 2017 under the condition that compensatory measures be taken, which the Beznau NPP has already complied to.

2.11 Separation and Independence

ENSREG recommendation 3.2.11: The enhancement of the functional separation and independence of safety systems. Examples include the elimination of full dependence of important safety functions on auxiliary systems such as service water and the introduction of an alternate source of cooling.

PP3

In the Swiss legal framework the Nuclear Energy Ordinance (NEO) requires physical separation and independence of safety systems. The newer Swiss NPPs are designed from the beginning with the special emergency safety systems functionally separated and independent from the classical safety systems. In the older Swiss NPPs the special emergency safety systems were backfitted in the 90s.

During the Periodic Safety Reviews (PSRs) which are performed every ten years, compliance of the NPPs with the regulatory requirements is extensively checked. Appropriate improvements may result from the PSR reviews.

Additional analyses have been initiated especially within the frame of the EU stress tests. A redundant, diverse ultimate heat sink needs to be implemented in the Mühleberg NPP (see ENSREG recommendation 3.2.1).

In order to limit the consequences of an internal flooding that could affect more than one safety system, the Mühleberg NPP has taken measures both on the preventive side, by reducing the amount of water that could be released after pipe breaks, and on the coping side ,with plans of backfitting an additional line for RPV-injection as accident management measure.

2.12 Flow Path and Access Availability

ENSREG recommendation 3.2.12: 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.

PP2 / PP11 / PP16
OP5-1

2012: ENSI conducted inspections on the status of the provisions for coping with a long lasting SBO. A verification of the robustness of the containment and primary circuit isolation was submitted by the operators.

2013: ENSI reviewed the submitted documents on containment and primary circuit isolation and concluded that the equipment employed is seismically robust enough to withstand loads according to the newest seismic hazard assumptions available (PRP intermediate hazards).

2014: As an improvement measure, the Gösgen NPP increased the seismic resistance of the conventional emergency diesel generators which are needed for the supply of the containment isolation valves. As mentioned in chapter 0.3 for ENSREG recommendation 2.3, the operators submitted the studies related to containment integrity in case of a SBO during outages in October 2014. These reports are currently under ENSI review.

2.13 Mobile Devices

ENSREG recommendation 3.2.13: *The provision of mobile pumps, power supplies and air compressors with prepared quick connections, procedures, and staff training with drills. Mobile devices are intended to enable the use of existing safety equipment, enable direct feeding of the primary or secondary side, allow extended use of instrumentation and operation of controls, allow effective fire-fighting, and ensure continued emergency lighting. The equipment should be stored in locations that are safe and secure even in the event of general devastation caused by events significantly beyond the design basis (this also applies to Topic 3 recommendations).*

PP12 / PP13 / PP15 / PP16
OP5-1

2011: Creation of an external storage facility at Reitnau, containing various operational provisions that can readily be called up in case of an emergency.

2013: Test of the severe accident equipment stored in Reitnau during an emergency exercise (see ENSREG recommendation 3.2.4).

2014: In addition to the operational provisions at the external storage facility Reitnau, additional emergency equipment is now being stored on-site (see also chapter 3.2 recommendation 3.3.2).

2.14 Bunkered/Hardened Systems

ENSREG recommendation 3.2.14: *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.*

PP18 / PP19 / PP12

Recommendation already implemented.

The Swiss NPPs already have bunkered systems containing the special emergency safety systems specially designed against external hazards (including man-made threats).

2.15 Multiple Accidents

ENSREG recommendation 3.2.15: The enhancement of the capability for addressing accidents occurring simultaneously on all plants of the site. Examples include assuring preparedness and sufficient supplies, adding mobile devices and fire trucks and increasing the number of trained and qualified staff.

PP12 / PP16 / PP18 / PP19

In Switzerland only the Beznau NPP is a multi-unit plant with two blocks of 365 MW_e each. In the year 2013, the organizational aspect of this issue has been addressed in the course of the revision of the Emergency Preparedness Regulation. It should be noted that a major backfitting project is about to be completed in Beznau (final implementation scheduled for the 2015 outage) with the upgrade of its emergency power supply which should provide for an improved separation between the two blocks with added dedicated resources.

In general terms, the capacity to address multi-unit accidents has been improved through the erection of the external storage facility in Reitnau and the added emergency equipment stored on site. The necessity of additional personnel with radiation protection expertise able to support the qualified radiation protection staff in an emergency will be defined by the regulatory body in 2015.

Furthermore, for multi-unit facilities the dependencies and interfaces among the units have to been addressed in the periodic safety reviews as required by the newly issued regulatory guideline ENSI-A03 "Periodic Safety Review of NPPs".

2.16 Equipment Inspection and Training Programmes

ENSREG recommendation 3.2.16: 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.

PP12 / PP16 / PP18 / PP19

The Basic Inspection Programme (BIP) already includes an extended scope of topics related to emergency preparedness. A typical example is the filtered containment venting system which was inspected again in detail at all plants in 2011. Emergency power systems and diesels are equally regularly subjected to inspection with regard to operational readiness.

2011: On the basis of the submitted documentation and inspection results, ENSI concluded that the Reitnau external storage facility is a viable facility for the purposes of storing equipment and auxiliary supplies in order to extend the emergency preparedness of the Swiss NPPs in case of severe accidents.

2013: Equipment, procedures and organization of the Reitnau external storage facility were tested during an alarm exercise and the general emergency drill.

Following an analysis by ENSI, the BIP was extended beyond the already regularly inspected items related to emergency preparedness and response to include:

- The process of updating and verification of emergency documentation incl. SAMG (content, update status, completeness);
- The operational readiness of the onsite and offsite emergency control centres including ventilation systems, personal protection equipment (e.g. dosimeters, radiation measurements instruments), availability of iodine tablets, instruments for the monitoring of breathing air quality, availability and access to food and water supply, lighting; and
- The process of warehouse management in the Reitnau external storage.

2.17 Further Studies to Address Uncertainties

***ENSREG recommendation 3.2.17**: The performance of further studies in areas where 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 an SBO (this is partially addressed in recommendation 3.2.10).*
- *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.).*

PP1 / PP2 / PP6 / PP14 / PP15 / PP16

After Fukushima, the issues related to SFP have been re-assessed by the Swiss operators and reviewed by ENSI. Backfitting were also implemented (e.g. external hook-up points for water make-up into the SFP; backfitting of level and temperature instrumentation for the SFP). Further studies regarding hydrogen dispersion have been performed (see ENSREG recommendations 2.3 (chapter 0.3) and 3.3.10).

For SBO please refer to the above recommendations.

Extensive infrastructure damage is the subject of studies performed in the frame of the activities of the interdepartmental working group to review emergency preparedness measures in case of extreme events in Switzerland IDA-NOMEX (see ENSREG recommendation 3.3.9 and chapter 5).

ENSI supports and coordinates safety research within its regulatory powers. The results of that research directly influence its Guidelines, regulatory decisions and resources. Research projects serve also training purposes by maintaining competence within ENSI and among its experts. ENSI's research programme contributes to international projects which Switzerland would be unable to conduct on its own. International exchange of expertise is thereby encouraged.

3 Severe Accident Management

3.1 WENRA Reference Levels

ENSREG recommendation 3.3.1: 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. This would include:

- *Hydrogen mitigation in the containment: Demonstration of the feasibility and implementation of mitigation measures to prevent massive explosions in case of severe accidents.*
- *Hydrogen monitoring system - Installation of qualified monitoring of the hydrogen concentration in order to avoid dangerous actions when concentrations that allow an explosion exist.*
- *Reliable depressurization of the reactor coolant system – Hardware provisions with sufficient capacity and reliability to allow reactor coolant system depressurization to prevent high-pressure melt ejection and early containment failure, as well as to allow injection of coolant from low pressure sources.*
- *Containment overpressure protection - Containment venting via the filters designed for severe accident conditions.*
- *Molten corium stabilization - Analysis and selection of feasible strategies and implementation of provisions against containment degradation by molten corium.*

PP28

ENSI has committed to incorporate all WENRA reference levels in its guidelines. Before the last revision of the WENRA reference levels (see below) the process was completed to a high percentage (more than 80%). The explanatory reports (accompanying each ENSI guideline) contain an updated list of all relevant IAEA requirements and guides and WENRA reference levels which are covered by each guideline.

After Fukushima, WENRA created additional topical working groups dedicated to tackle the issues of: Mutual assistance, Natural Hazards, containment in severe accidents, Accident Management (AM) and Periodic Safety Reviews (PSRs).

ENSI participates actively in all the topical working groups. WENRA revised Safety Reference Levels were published in September 2014 /19/ and will be included in the regulation by ENSI.

3.2 SAM Hardware Provisions

ENSREG recommendation 3.3.2: 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.

PP1 / PP15 / PP16
OP5-1

Accident Management (AM) provisions are available on the Swiss NPPs sites and offsite. After Fukushima, these provisions were checked and improvements implemented (e.g. additional onsite AM-DGs). Beyond that, the Reitnau external storage facility was established in June 2011 (see ENSREG recommendation 3.3.14). The ready availability of the SAM equipment stored on-site will be addressed by the regulatory body.

3.3 Review of SAM Provisions Following Severe External Events

ENSREG recommendation 3.3.3: 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.

PP15 / PP16
OP5-1

AM provisions are available on the Swiss NPPs sites and offsite. After Fukushima, these provisions were checked and improvements implemented (e.g. additional onsite AM-DGs). Beyond that, the Reitnau external storage facility was established in June 2011 (see ENSREG recommendation 3.3.14).

3.4 Enhancement of Severe Accident Management Guidelines

ENSREG recommendation 3.3.4: 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.

PP15 / PP16
OP5-1

The severe Accident Management Guidelines (SAMGs) of the Swiss NPPs are generally symptom-based and thus not only focused on specific scenarios. In Switzerland, the adequacy of SAMGs is continuously reviewed within the frame of PSRs and emergency exercises.

3.5 SAMG Validation

ENSREG recommendation 3.3.5: The validation of the enhanced SAMGs.

PP15 / PP16
OP5-1

In Switzerland, the adequacy of SAMGs is continuously reviewed in PSRs and emergency exercises.

3.6 SAM Exercises

ENSREG recommendation 3.3.6: 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.

PP15 / PP16
OP5-1

2011: Start of the revision of Guideline ENSI-B11 "Emergency exercises".

2013: The revised version of ENSI-B11 includes regular emergency exercises with the involvement of fire brigades and security forces. Beyond that, the revised ENSI-B11 foresees the possibility of long-lasting exercises (e.g. with more than one shift change). The communication among different organisations and transboundary partners are to be regularly checked during the general emergency drills.

The procedures of the activation of the Reitnau external storage facility and the provision of SAM equipment and its transportation from the external storage facility to the plants have been tested. These tests were carried out as part of an unannounced alarm exercise in one NPP and during a national emergency drill.

3.7 SAM Training

ENSREG recommendation 3.3.7: 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.

PP15 / PP16
OP5-1

The Guideline ENSI-B11 describes the requirements for emergency exercises. The revised ENSI-B11 foresees the possibility of long lasting exercises (see ENSREG recommendation 3.3.6).

2013: During the national emergency drill AM equipment was tested (also from the Reitnau external storage facility) as well as procedures and organisational processes. The underlying scenario implied damages to two NPPs, namely the Leibstadt NPP and the Beznau NPP with its twin units.

3.8 Extension of SAMGs to All Plant States

ENSREG recommendation 3.3.8: The extension of existing SAMGs to all plant states (full and low-power, shutdown), including accidents initiated in SFPs.

PP15 / PP16
OP5-1

The SAMGs of the Swiss NPPs cover already all plant states and include the SFPs.

3.9 Improved Communications

ENSREG recommendation 3.3.9: 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.

PP9 / PP15 / PP17 / PP20 / PP22 / PP23

The effects of damage to infrastructure and communication systems are addressed by IDA-NOMEX (see chapter 5). The work on the measures suggested by IDA-NOMEX is in progress.

2013: ENSI and the NPPs have introduced the so-called POLYCOM (radio-based communication network also used by the rescue teams in Switzerland) as an alternative communication system. The system has been tested also in the general emergency drill.

2014: Beyond POLYCOM, which is not suitable for data transfer, ENSI has been exploring further means of communication, for example the use of satellite-based communication among emergency response partners is under consideration.

3.10 Presence of Hydrogen in Unexpected Places

ENSREG recommendation 3.3.10: 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.

PP7
OP6-1
PRT-2

2012: The licensees have submitted their investigations regarding protection against hydrogen hazards in the area of the spent fuel pools. Based on its review of the submitted documentation, ENSI has imposed specific additional requests for each plant to ensure monitoring of the spent fuel pools, upgrading of the SFP cooling systems and extension of the relevant on-site emergency preparedness measures. These measures additionally reduce the risk of a severe accident in the area of the SFP.

2014: The licensees submitted the requested studies on hydrogen mitigation in the containment and about migration of hydrogen to buildings outside the containment. Some licensees proposed to equip their containment with Passive Autocatalytic Recombiners (PARs). ENSI's review of all these studies is ongoing. Preliminary results seem to confirm the need of backfitting measures in those NPPs without inertization. Further updates of the plant-specific SAMGs may be required to complement the hardware implementation.

3.11 Large Volumes of Contaminated Water

ENSREG recommendation 3.3.11: The conceptual preparations of solutions for post-accident contamination and the treatment of potentially large volumes of contaminated water.

PP34 / PP35

2013: ENSI issued a report on the situation in Switzerland in case of a discharge of large quantities of radioactivity into the Aare and Rhine rivers. It concluded that the measures to protect the population are in principle adequate. Some improvements e.g. in the alarming process and continuous surveillance of radioactivity have been identified.

ENSI has required the licensees to examine those cases in which large quantities of radioactively contaminated water can be expected in their plant, the routes by which these quantities of water can reach the surrounding area, and the methods that can be used to retain and/or minimise them.

2014: The implementation of the above mentioned improvements was initiated and should be completed by the end of 2015. To verify the improvements, a tabletop-exercise and at least one alarm exercise are planned until the end of 2015.

The licensees have developed a basic concept for dealing with large quantities of water. By the end of 2015, the licensees will complete the corresponding plant-specific investigations.

3.12 Radiation Protection

ENSREG recommendation 3.3.12: The provision for radiation protection of operators and all other staff involved in the SAM and emergency arrangements.

PP18 / PP31

Within its regulatory oversight, ENSI routinely checks radiation protection measures for severe accident situations in all Swiss NPPs, including rescue teams. Additional radiation protection equipment in case of an emergency is available at the Reitnau external storage facility. Radiation protection material was inspected in 2013 at all NPP sites and found in compliance with the requirements.

3.13 On Site Emergency Centre

ENSREG recommendation 3.3.13: 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.

PP10 / PP11

All Swiss NPPs have protected on-site emergency centres.

2012: ENSI carried out inspections of the ECC at NPP sites. ENSI requested the plants to submit a report on the long-term operability of the emergency control centre (ECC) and substitute ECC after a core damage accident with large releases.

2013: The plants submitted their reports on the long-term operability of the ECCs.

2014: Assuming a long lasting large release, ENSI's review of the submitted reports underlined the importance of an off-site ECC facility as an alternative to the protected infrastructure on-site.

3.14 Support to Local Operators

ENSREG recommendation 3.3.14: 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.

PP18 / PP19 / PP31

2011: Creation of an external storage facility at Reitnau, containing various operational provisions for emergencies that can readily be called up. Transport by road or air transportation by helicopter are planned options. Beyond off-site equipment, it's worth mentioning that mobile accident management equipment stored on-site has been significantly upgraded.

2013: Test of the procedures of the activation of the Reitnau external storage facility and the provision of SAM equipment and its transportation from the external storage facility to the plant. These tests have been carried out as part of an unannounced alarm exercise and an emergency exercise in one plant.

3.15 Level 2 Probabilistic Safety Assessments (PSAs)

ENSREG recommendation 3.3.15: 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.

Guideline ENSI-A05 "Probabilistic safety analysis: quality and scope" already requires all Swiss NPPs to develop and maintain level 2 PSAs covering all relevant accidents due to internal or external events in all plant states. The Swiss NPPs have developed their level 2 PSAs accordingly.

The SAMGs of the Swiss NPPs are generally symptom based and thus not only focused on specific scenarios. PSA is not used to reduce the scope of SAMGs, but applied to check the completeness of considered measures in the SAMGs and to support the technical basis.

3.16 Severe Accident Studies

ENSREG recommendation 3.3.16: *The performance of further studies to improve SAMGs. Examples of areas that could be improved with further studies include:*

- *The availability of safety functions required for SAM under different circumstances.*
- *Accident timing, including core melt, reactor pressure vessel (RPV) failure, basemat melt-through, SFP fuel uncovery, etc.*
- *PSA analysis, including all plant states and external events for PSA levels 1 and 2.*
- *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.*
- *Core cooling modes prior to RPV failure and of re-criticality issues for partly damaged cores, with un-borated water supply.*
- *Phenomena associated with cavity flooding and related steam explosion risks.*
- *Engineered solutions regarding molten corium cooling and prevention of basemat melt-through.*
- *Severe accident simulators appropriate for NPP staff training.*

PP16

The regular review of the PSA addresses the issues listed in the recommendation.

The SAMGs of the Swiss NPPs are generally symptom-based and thus suitable to cover a comprehensive set of scenarios. Recently the use of mobile or accident management equipment to cope with an SBO received special attention, including focused inspections by ENSI.

The SAMGs of the Swiss NPPs cover all plant states and include the SFPs. Studies with relevance to the SAMGs are continuously being performed. ENSI and the operators independently cooperate with national and international research institutions to increase knowledge on severe accident behaviour.

Part II: Implementation of the additional CNS recommendations derived from the 2nd Extraordinary Meeting 2012 (areas 4-6)

4 National Organisation in respect of Nuclear Safety

This chapter focuses on the general organizational topics relevant for maintaining and enhancing nuclear safety. The responsibilities in an emergency are described in chapter 5.

4.1 Functions and Responsibilities of the Regulatory Body

4.1.1 Independence

***CNS-EOM recommendation 3**: Ensure that its regulatory body is effectively independent in making regulatory judgments based on scientific and technological grounds and taking enforcement actions and that it has functional separation from entities having responsibilities or interests, such as the promotion or utilisation of nuclear energy (including electricity production), that could conflict with safety or other important regulatory objectives or otherwise unduly influence the decision making of the regulatory body.*

PP30

The Nuclear Energy Act requires the supervisory authorities to be formally independent from the licensing authorities and not bound by (technical) instructions. It also clarifies and details the role, duties and responsibilities of ENSI as the supervisory authority for nuclear safety in terms of the development of safety criteria and the maintenance of nuclear safety.

Since the beginning of 2009, ENSI is an independent body constituted under public law. It reports directly to the Government but is completely separate from the Swiss Federal Office of Energy (SFOE) to which was annexed before. In other words, the regulatory body is now legally, institutionally, politically and financially independent. This was recognised as a good practice by the Integrated Regulatory Review Service (IRRS) team during the IRRS mission to Switzerland in 2011.

4.1.2 Legal authority

***CNS-EOM recommendation 4**: Ensure the effectiveness of its regulatory body by providing for adequate legal authority, sufficient human and financial resources, staff competence, access to necessary external expertise for its decision-making based on adequate scientific and technical knowledge, access to international cooperation, and other matters needed for fulfilling its responsibilities for the safety of nuclear installations.*

***CNS-EOM recommendation 7**: Include information in its National Report on its efforts to ensure the independence, effectiveness and transparency of its regulatory body*

PP29 / PP30

Costs incurred by the safety authorities (with the exception of those related to the development of the regulatory framework and to providing information to the public), totalling some 60 million Swiss francs per year, are mainly covered by fees from licensees.

Knowledge management and training measures are an integral part of ENSI's Management System. The process includes an annually updated systematic compilation of the skill and knowledge requirements for each organisational unit. Staff training is based on this compilation (see also the 6th National Report of Switzerland to the Convention on Nuclear Safety /11/).

ENSI is able to exercise its authority to intervene in cases where nuclear facilities or activities may pose significant radiation risks. According to the Nuclear Energy Act, ENSI shall order all necessary and reasonable measures aimed at preserving nuclear safety and security. In the event of an immediate threat, it may impose immediate measures that deviate from the issued license(s) or order(s).

4.2 Openness, Transparency and Communication

4.2.1 Regulatory structure

CNS-EOM recommendation 6: Ensure that its regulatory body operates in a transparent and open manner, taking into account legitimate concerns over security and other sensitive interests that might be adversely affected by the public disclosure of particular information.
CNS-EOM recommendation 7: Include information in its National Report on its efforts to ensure the independence, effectiveness and transparency of its regulatory body.

PP29 / PP30

Under Article 74 of the Nuclear Energy Act, ENSI "shall regularly inform the general public about the condition of nuclear installations and any matters pertaining to nuclear goods and radioactive waste" and "shall inform the general public of any special occurrences". In addition to that, ENSI is obliged to respond to questions from the parliament on nuclear safety and the work of the regulatory body. As a federal authority, ENSI is subject to the Federal Act on Freedom of Information in the Swiss administration. According to this law, all ENSI documents are public bar some protected information, such as security-related information, personal data or trade secrets.

4.2.2 Communication

ENSI regularly informs the public about its activities. For instance, it organises regular meetings with stakeholders like the mayors of the emergency planning zones 1 and 2. In these meetings, all aspects of safety, including emergency preparedness and response (see chapter 5) are addressed.

In 2009, in connection with the so-called sectoral plan, a process established in Switzerland for choosing the sites for deep geological repositories, the SFOE set up the Technical Forum on Safety (TFS). The TFS, which is led by ENSI, discusses and answers technical and scientific questions asked by the public, communities, siting regions, organisations, cantons and authorities in neighbouring states. The forum comprises experts from the body leading the process (SFOE), from other bodies with supervisory or supportive roles (ENSI, Swiss Federal Office of Topography (swisstopo)), from commissions (Federal Nuclear Safety Commission (NSC), from the

National Cooperative for the Disposal of Radioactive Waste (Nagra), from the cantons), and includes one representative from each of the siting regions.
A similar panel (Technical Forum on NPPs) was created by ENSI in 2012 for topics related to the safety of NPPs. All results of the work conducted in the Technical Fora are publicly available (in German) on the ENSI website[1].

The communication services of ENSI regularly provide direct information to the public. ENSI's website www.ensi.ch is an important information dissemination tool covering all aspects of nuclear safety in Switzerland in the national languages of German and French as well as some aspects in Italian and English. It is accompanied by activities on social media.

4.2.3 Transparency

***CNS-EOM recommendation 12**: Make its National Report and any written questions and responses relating to that report publicly available, with the exception of any particular item of information that would adversely affect security or other sensitive interests if publicly disclosed and request the IAEA to maintain this information, other than any information covered by the above exception, on a website open to the public.*

***CNS-EOM recommendation 13**: Make any international peer review mission reports, any follow-up reports or any national responses to such reports publicly available, with the exception of any particular items of information that would adversely affect security or other sensitive interests if publicly disclosed and request the IAEA to maintain this information, other than any information covered by the above exception, on a website open to the public.*

***CNS-EOM recommendation 14**: Include information in its National Report on its efforts to enhance openness and transparency in the implementation of its obligations under the Convention on Nuclear Safety.*

***CNS-EOM recommendation 15**: Enhance the robustness of the peer review of national reports submitted under the CNS through the preparation and submission of thorough reports that present successes and challenges and the frank discussion of these reports.*

PP29

Reports to international organisations as well as results of peer reviews are publicly available on the ENSI website (see also chapter 6.1).

As regards the issue of stakeholder consultations, the Swiss Nuclear Energy Act provides the frame for the involvement of interested parties in the authorization process for nuclear facilities. In particular, the broad involvement of the Swiss local and regional population in the process of choosing the site for the deep geological repository of radioactive waste (so called sectoral plan) has been commended in various occasions at the international level.

In its regulatory work ENSI is supported by several TSOs, whose contribution is embedded, following a traceable process, in ENSI's safety evaluation reports, permits and decisions. On important issues, e.g., in the frame of the licensing of nuclear installations, the Federal Nuclear Safety Commission provides a second opinion to ENSI's published decision. The IRRS 2011 mission to Switzerland recommended a modification of the current process so as to take into account the second opinion of the Federal Nuclear Safety Commission already before ENSI's final decision is issued. This has been accomplished by drafting a Memorandum of Understanding between ENSI and the Federal Nuclear Safety Commission that describes the process modifications: ENSI's

[1] http://www.ensi.ch/de/2012/09/03/ensi-forum-fragen-und-antworten-zur-sicherheit-von-kernkraftwerken/ and http://www.ensi.ch/de/2013/09/25/technischen-forum-kernkraftwerke-eingereichte-fragen/

final draft is sent to the Federal Nuclear Safety Commission for comments; upon receipt of said comments, ENSI issues its final decision with a detailed discussion in a dedicated annex of all the points raised by the Federal Nuclear Safety Commission including the justification of acceptance and/or refusal.

4.3 Human and Organizational Factors

***CNS-EOM recommendation 4**: Ensure the effectiveness of its regulatory body by providing for adequate legal authority, sufficient human and financial resources, staff competence, access to necessary external expertise for its decision-making based on adequate scientific and technical knowledge, access to international cooperation, and other matters needed for fulfilling its responsibilities for the safety of nuclear installations.*

***CNS-EOM recommendation 5**: Ensure that its regulatory body requires a licensee for a nuclear installation to have adequate expertise and resources to fulfill its responsibility for the safe operation of the nuclear installation, including effective response to any accident and mitigation of its consequences.*

PP29 / PP30 / PP36 / PP37

Swiss nuclear legislation stipulates that nuclear installations must be kept adequately safe and that the licensee must provide the personnel responsible for the safe operation of a nuclear installation with the necessary resources.

Under the Nuclear Energy Act, there must be a sufficient number of qualified staff with the expertise required to manage and control a nuclear installation during all phases of its life cycle. A minimum level of staffing with qualified personnel is stipulated for the plants on a 24-hour basis. This ensures that adequate staff is present in the plant at all times under normal conditions, to initiate alarms and to undertake the first measures required in case of an emergency. Moreover, most employees of Swiss NPPs are members of the respective Emergency Response Organisation (ERO), so the plants can always draw on a sufficient large pool of specialists for their ERO.

In August 2011, ENSI published a first report on its preliminary analysis of Human and Organisational Factors (HOF) in the Fukushima accident. Since then, it has continued to deepen the analysis. A follow-up report is planned with a tentative publication date in 2015. The purpose of the analysis is to deepen the understanding of the HOF that contributed to the accident and to draw the necessary lessons for the regulatory oversight in the HOF domain.

In 2012, ENSI conducted technical discussions with each NPP on the implications for their safety culture of the Fukushima accident and the following political decision to phase out of nuclear energy in Switzerland. This kind of technical discussions has been described in a report on ENSI's approach to the regulatory oversight of safety culture /20/.

Moreover, ENSI initialised a process of self-reflection on its own oversight culture and its effect on the licensees' nuclear safety and safety culture. The project was conducted over three years in three phases. Phase I and phase II consisted of an analysis of the current oversight culture and the definition of the oversight culture ENSI strives for. In phase III a set of concrete measures was developed in order to foster and facilitate the "embodiment" of the Mission Statement's content and the results of phases I and II of the project in ENSI's regular oversight activities. The measures are currently being implemented.

5 Emergency Preparedness and Response and Post-Accident Management

5.1 National Responsibilities for safety

The regulatory framework in Switzerland clearly allocates responsibilities and specifies the functions of the authorities responsible for safety. In case of an emergency, specific legal provisions apply, defining the tasks of the competent authorities and of the operators of nuclear facilities. In the event of a radiological emergency, the Federal NBCN (nuclear, biological, chemical, and natural) Crisis Management Board is called into action.

The NBCN Crisis Management Board consists of the directors of all federal offices concerned, including the ENSI Director General. It assesses the overall situation, proposes the necessary measures to the Federal Council (government), ensures coordination with other authorities and the deployment of resources required to cope with the event (e.g. civil and military elements, expert support by laboratories). It runs a stand-by emergency service, the National Emergency Operations Centre (NEOC), which is responsible for alerting and informing the public and for initiating early countermeasures in the event of a radiological accident.

5.2 Protection measures

In May 2011, the Swiss Federal Council decided to appoint an interdepartmental working group to review emergency protection measures in case of extreme events in Switzerland (IDA-NOMEX). The remit of this working group, in which ENSI was also represented, was to examine in the light of the Fukushima accident whether further action is required regarding emergency protection in case of extreme events in Switzerland, and whether any new statutory and organisational emergency protection measures need to be taken.

In July 2012, the Federal Council acknowledged the report of the working group IDA-NOMEX and issued 56 tasks for the elaboration of organisational measures in the field of personnel and material for emergency management, improvement of the coordination and cooperation at national level and the clarification of responsibilities.

The reference scenario for emergency planning and the zone concept in the vicinity of NPPs were reviewed and the pre-distribution of iodine tablets to the population was extended to a distance of 50 km around the NPPs sites. The possible release of contaminated waters in the course of an accident is currently being addressed (see ENSREG recommendation 3.3.11 in chapter 3.11).

5.3 Exercises and international cooperation

The emergency preparedness in Switzerland and its response at the international level is regularly verified by its participation in international exercises conducted by the IAEA or European Community Urgent Radiological Information Exchange (ECURIE). The OECD/NEA INEX exercises are another opportunity to verify certain aspects of emergency management. Switzerland usually participates in these exercises.

In 2011, the IRRS Team had the opportunity to observe an emergency exercise. The IRRS report summarizes the result of this peer review: beyond the good practices some areas for improvements including one recommendation were identified. Since then, ENSI has worked to the solution of all issues identified. As an example, longer emergency exercises with several shift changes have already been introduced in the regulation and such a longer drill took place as national general emergency exercise in 2013. The IRRS Team recommended

that ENSI should make the emergency classification consistent with GS-R-2. Resolution of this issue has required an extensive analysis work by the licensee as well as the regulators: the already existing Emergency Action Levels (EALs) will be complemented and the EALs assigned to the newly defined classes. It is expected that the implementation of the new classification system in the NPPs will be completed by 2016.

Switzerland also participates in working groups of the Heads of the European Radiological protection Competent Authorities (HERCA) and WENRA on emergency preparedness.

Finally, in order to improve the emergency response system at the national and international level, members of ENSI and the National Emergency Operations Centre actively support the activities of the OECD/NEA working party on Nuclear Emergency Matters.

6 International Cooperation

This chapter focuses on Switzerland's international contractual obligations and cooperation activities which are considered to be relevant in the context of the Fukushima accident and the lessons learned from it. In light of this accident, Switzerland decided to further increase its engagement and contributions to strengthening the global nuclear safety regime.

ENSI is represented in more than 70 international committees. The majority of these bodies are part of the IAEA and the Nuclear Energy Agency (NEA) of the OECD. Furthermore, ENSI actively participates in several international organisations: chairing the WENRA since 2012, chairing the European Nuclear Security Regulators Association (ENSRA) in 2012, as an observer in the ENSREG together with the European Nuclear Energy Forum (ENEF), as a member of the HERCA, chairing HERCA's working group on emergencies and as a member of the European Union Clearinghouse on Operating Experience Feedback for Nuclear Power Plants.

ENSI actively participated in the IAEA working group on effectiveness and transparency to improve the CNS and its review conferences. Switzerland made a proposal to amend the CNS. A diplomatic conference will take place in 2015 to discuss the proposed amendment to the convention.

6.1 International Peer Reviews Missions

6.1.1 IRRS Missions

CNS-EOM recommendation 8: Host, as appropriate, an international peer review mission of its regulatory framework governing the safety of nuclear installations, if the Contracting Party has an operating nuclear installation.

PP29

From the very beginning Switzerland, and in particular its nuclear regulatory body ENSI, committed to international peer review missions. Switzerland was the first western country to request a mission by an IAEA International Regulatory Review Team (IRRT) in 1998. A follow-up was hosted in 2003 and ENSI has provided experts to participate in various IRRT and IRRS missions in the past. According to the ENSI ordinance, ENSI has to periodically host international peer review missions in order to check its compliance with the IAEA Safety Standards.

The last IRRS mission in Switzerland took place in 2011. The final report by the review mission contains 19 Good Practices, 12 Recommendations and 18 Suggestions. A Good Practice was given to the fact that the ENSI ordinance requires ENSI to undergo an IRRS mission periodically. By the end of 2012, ENSI drafted an action plan on the measures needed to cope with the mission findings in view of the IRRS Follow-Up mission which is scheduled for April 2015.

Furthermore, ENSI experts so far have participated in around twenty IRRT and IRRS missions (including follow-up missions) to other countries and chaired three of these missions.

6.1.2 OSART Missions

CNS-EOM recommendation 9: Host regularly, as appropriate for the size and number of the nuclear installations within that Contracting Party, international peer review missions of the operational safety of its nuclear installations, if the Contracting Party has an operating nuclear installation.

Pp29

From 1994 to 2000 the Swiss NPPs hosted OSART missions, including follow-up missions, and all of them have implemented the recommendations received in the OSART reports. ENSI asked the NPPs to plan for regular OSART missions, possibly to be alternated with the WANO missions. All Swiss NPPs are member of the WANO and have a schedule for periodic WANO Peer Reviews.

Following the recommendation from the IAEA Action Plan on Nuclear Safety, Switzerland requested a new OSART mission for the Mühleberg NPP which reached 40 years of commercial operation in 2012. The OSART mission took place in October 2012 and the follow-up mission in June 2014.

6.1.3 Reports

CNS-EOM recommendation 11: Include information in its National Report on any international peer review missions under paragraph 1, 2 or 3 of this section that the Contracting Party has hosted in the period between two review meetings of the Contracting Parties including a summary of the findings, recommendations and other results of the missions, actions taken to address these results, and plans for follow-up missions.

CNS-EOM recommendation 15: Enhance the robustness of the peer review of national reports submitted under the CNS through the preparation and submission of thorough reports that present successes and challenges and the frank discussion of these reports.

PP29

Switzerland's 6th National Report to the CNS /11/ presents the results of both the IRRS Mission from 2011 and the OSART Mission to the Mühleberg NPP from 2012. These three reports are available on ENSI website.

All Swiss OSART reports are derestricted and available to the public /13/, /14/. All Swiss country reports for the Convention on Nuclear Safety (CNS) and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management are published on ENSI's website.

6.2 Global Safety Regime and Expanded use of IAEA Safety Standards

CNS-EOM recommendation 1: Take the IAEA Safety Standards into account in enhancing nuclear safety.

CNS-EOM recommendation 2: Include information in its report under the Convention on Nuclear Safety (National Report) about how it has taken or intends to take the IAEA Safety Standards (including, in particular, the Safety Fundamentals and Requirements) into account in implementing its obligations under the Convention on Nuclear Safety.

PP29

As a consequence of the Fukushima accident, Switzerland advocates strengthening the global system for nuclear safety. The background for this position is the call for mandatory IAEA review missions to all countries with NPPs to assess their regulatory framework and activities as well as their NPP's siting, design and operation. Furthermore, Switzerland aims for more transparency in the reporting on the CNS meetings and the review missions, by calling for mandatory publication of the review results. The IAEA Action Plan on Nuclear Safety, which was endorsed by the IAEA General Conference of September 2011, includes these elements on a non-mandatory basis and is considered to be a first step towards the effective strengthening of the global nuclear safety regime.

At the Second Extraordinary Meeting of the Convention on Nuclear Safety that was held in August 2012, Switzerland proposed various amendments to the Convention. To accommodate those, a working group entrusted with the task of strengthening the Convention was established. Switzerland actively participated in this working group. ENSI reaffirmed this position during the Fukushima Ministerial Conference on Nuclear Safety in December 2012.

In its 6th national CNS report Switzerland /11/ promotes the idea that the use of IAEA Safety Standards should be strengthened in regular peer review missions on the assessment of the regulatory framework and activities, on NPP design and on NPP operation. Switzerland also proposed an amendment to article 18 of the Convention aiming at setting safety goals for new plants as well as existing reactors. The amendment proposal will be further discussed during the diplomatic conference of 2015[2].

The Swiss legal framework governing the safe use of nuclear energy is widely based on the IAEA Safety Standards. In 2005, ENSI started its comprehensive project to develop a new regulatory framework. This process has progressed well over the past years. The IAEA safety standards are systematically taken into account during the drafting process of ENSI guidelines. ENSI will continue its efforts to complete the regulatory framework considering the current IAEA Safety Standards. As an example, the radiation protection ordinance is currently being revised with the objective of achieving full compliance with international standards.

ENSI is actively involved in the IAEA Safety Standard drafting committees (Nuclear Safety Standards Committee (NUSSC), in the Radiation Safety Standards Committee (RASSC), in the Transport Safety Standards Committee (TRANSSC), in the Waste Safety Standards Committee (WASSC) and in the Nuclear Security Guidance Committee (NSGC)) and thereby contributes to their strengthening.

6.3 International Communication Mechanisms

Switzerland has signed bilateral treaties on the early notification and mutual assistance in case of a nuclear emergency with all neighbouring countries. Based on these treaties, bilateral commissions of the nuclear safety authorities were established and usually meet once a year. These bilateral commissions also exchange operational and regulatory experience and cooperate in emergency preparedness and response matters. The French-Swiss and the German-Swiss commissions comprise dedicated sub-commissions for EP&R.

Incidents and accidents in Switzerland are reported to the IAEA Incident and Emergency Centre (IEC) by using the Unified System for Information Exchange in Incidents and Emergencies (USIE). In case of a serious incident or an accident in a Swiss nuclear installation, the national emergency response organisation is mobilised according to the Emergency Protection Ordinance and the Ordinance on the Organisation of Operations in Connection with NBCN Events, defining the governmental bodies responsible for mitigation of the accident, their duties and communication lines (see chapter 5). According to the Convention on Early Notification of a Nuclear Accident and corresponding bilateral agreements with Switzerland's neighbouring countries, the IAEA

[2] http://www.ensi.ch/en/2014/10/03/switzerland-is-lobbying-to-introduce-stricter-safety-provisions-for-nuclear-power-plants-throughout-the-world/

and the authorities of Germany, France, Italy and Austria are notified instantly. Switzerland is part of the EMERCON and ECURIE information systems. Furthermore, Switzerland is a member of RANET since March 2014.

An automatic dose rate monitoring and emergency response data system has been installed for all NPPs in Switzerland. The data is transmitted online to ENSI, the National Emergency Operations Center and – regarding the Leibstadt and Beznau NPPs which are close to the German border – also to the responsible authorities in Germany. This data is also transmitted to EURDEP, the European Radiological Data Exchange Platform of the European Commission. ENSI's radiological prediction results are provided to the National Emergency Operations Centre and to the German authorities.

6.4 Operating Experience Feedback

The Swiss Nuclear Energy Act, the Nuclear Energy Ordinance NEO and regulatory guidelines include requirements on the notification of events. The NEO also requires each plant to form a group that investigates events, defines corrective actions and follows through their implementation to prevent events from reoccurring. The insights from these events, as well as from international events, must be reported to ENSI at least every three months. In addition, operators are legally obliged to review their NPP design after every INES-1-event in their own plant or after any INES-2-event in another NPP in Switzerland or abroad.

ENSI reviews domestic and international operating experience. The review of operating experience may result in regulatory action and, as appropriate, in requirements to the operator. The yearly assessment of the safety situation at each Swiss NPP is based on the operating experience. This systematic safety assessment, which includes findings from inspections as well as from event investigations, is for instance used to focus the inspections on a particular aspect in the following year, representing a true feedback of operating experience into the regulatory actions.

ENSI issues an annual report compiling information on regulatory safety research, lessons learned from events in foreign NPPs, international cooperation and current changes and developments in the basics of the nuclear regulatory process. In some cases, e.g. for incidents of global interest or with main relevance to Swiss NPPs, ENSI prepares reports on its examination and response actions (e.g. the report on the event at Forsmark 1 on 25 July 2006, or the four reports on the analysis of the Fukushima accident).

Nuclear incidents in Switzerland are reported to the International Reporting System for Operating Experience (IRS) jointly operated by the IAEA and the NEA. ENSI is a member of the NEA Working Group on Operating Experience (WGOE), the NEA Working Group on Inspection Practices (WGIP) and the European Network on Operational Experience Feedback (EU Clearinghouse). Sharing of operating and regulatory experience is also a constant agenda item of the bilateral commission meetings with the neighbouring countries. On a bilateral level, inspectors of the French Nuclear Safety Authority regularly participate in so-called cross inspections in Swiss NPPs and vice versa.

Part III: National conclusions and generic activities derived from national reviews and related decisions

7 Fukushima Action Plan

As a direct consequence of the Fukushima accident in Japan, ENSI issued three formal orders in which the operators of the Swiss NPPs were required to implement immediate measures and to conduct additional reassessments. The immediate measures comprised the establishment of an external emergency storage facility for the Swiss NPPs (implemented in Reitnau) including the necessary plant-specific connection points, and those backfittings that would allow water injection into the spent fuel pools (SFPs) without accessing the SFP area. The additional re-assessments, which were to be carried out immediately, focused on the design of the Swiss NPPs against earthquakes, external flooding and a combination thereof. Investigations on the coolant supply for the safety systems and the SFP cooling on the basis of first insights gained from the accident in Japan were also requested.

In addition to the aforementioned orders, and on the basis of the internationally accessible information, ENSI carried out an analysis of the events at Fukushima and published the results in four reports. These reports provide detailed descriptions of the causes, consequences and radiological impacts of the accident at Fukushima. Furthermore the reports analyse the contributory human and organisational factors, and specify lessons that can be derived from the accident. After a coarse check of applicability to the Swiss case 37 specific checkpoints (PP) were identified from the lessons learned for further investigation. Further open points (OP) were added to the list on completion of the analyses for the European Stress Tests. Two additional issues (PRT) were identified by the Peer Review Team of the European Stress Tests. A complete listing of the PPs, OPs and PRTs can be found in Chapters 7.1 and 7.2.

The issues related to the PPs, OPs and PRTs are being processed in a Swiss action plan, called "Action Plan Fukushima". This "Action Plan Fukushima" is updated and published on a yearly basis. It describes ENSI's oversight activities related to Fukushima. ENSI has set the goal of investigating the identified issues and implement the derived measures by 2015. Some additional major backfitting, in some case linked to requirements for LTO, may take two additional years to complete. For an overview on the status of all Fukushima issues, please refer to the yearly updates of the "Action Plan Fukushima" on ENSI's website.

7.1 List of checkpoints from the Swiss "Lessons Learned" report

No	Point designation	Description
1	PP1	The hazard assumptions for earthquake and external flooding, and also for extreme weather conditions, must be re-evaluated to take account of the latest knowledge.
2	PP2	The control strategies for a long-lasting total power failure must be re-evaluated on the basis of knowledge gained from Fukushima.
3	PP3	A review must be carried out to determine whether the coolant supply for the safety systems and the associated auxiliary systems is guaranteed from a diverse source which is safe against earthquakes, flooding and contamination.

No	Point designation	Description
4	PP4	A review must be carried out to determine whether the requisite tightness of buildings containing important safety equipment is guaranteed in case of flooding of the site.
5	PP5	On the basis of experience gained from the Fukushima accident, another review must be undertaken to determine whether the availability of the instrumentation required to assess the condition of the plants is guaranteed adequately even in extreme situations.
6	PP6	A review must be carried out to determine whether control of leaks and long-term cooling of the spent fuel pools are guaranteed in case of severe accidents.
7	PP7	A review must be carried out to determine whether tests and inspections regarding the prevention of hydrogen explosions should be extended to additional areas of the plants beyond the primary containment.
8	PP8	The design and operation of the systems for filtered venting of the containment must be reviewed again.
9	PP9	It is necessary to carry out a new review of the earthquake and flood design of the monitoring network for automatic dose rate measurement in the vicinity of nuclear power plants (MADUK), in relation to experience gained from the Fukushima accident.
10	PP10	A review must be carried out to determine whether the emergency rooms (ER) and the substitute emergency rooms (SER) at the Swiss nuclear power plants still meet the requirements, based on the experience gained from the Fukushima accident.
11	PP11	The access control system for nuclear power plants and the associated arrangements must be reviewed to determine the accessibility of rooms where intervention is required in case of severe accidents, while maintaining appropriate plant safety and security. Monitoring of radiation protection must continue to be guaranteed in this context.
12	PP12	The emergency measures for heat dissipation in case of a complete failure of the cooling water supply must be reviewed and verified under conditions resulting from the disruption of the infrastructure and the power supply.
13	PP13	It is necessary to review how the alternative supply of water and power for emergencies is ensured.
14	PP14	It is necessary to examine the water resources that can be made available to supply the reactor pressure vessel, the spent fuel pools and the containment.
15	PP15	Emergency management must be reviewed to determine further potential for improvement.
16	PP16	ENSI has identified the following issues as checkpoints for improving emergency planning and emergency exercises: a The decision-making aids for emergency management in case of severe accidents (SAMG) at nuclear power plants, including the newly planned checkpoints to deal with severe accidents, must be reviewed on the basis of knowledge gained from the Fukushima accident. In this regard, it is particularly necessary to check: - whether adequate consideration is given to a Station Blackout (SBO) of long duration and the simultaneous occurrence of events in multiple-unit plants - whether there is any need for measures, auxiliary resources and equipment that must be available to ensure that critical levels are not attained over the long term in case of severe accidents.

No	Point designation	Description
		b Consideration given to incidents involving an SBO of long duration in the planning of emergency exercises. c Examination of whether the procedures are trained often enough during emergency exercises. Particular attention should be focused here on a functioning inter-organisation chain of communication across the various organisations.
17	PP17	A review must determine whether and to what extent the communication facilities are designed with adequate redundancy and diversity.
18	PP18	It must be ensured that adequate staff is available at all times to accomplish all necessary emergency management activities.
19	PP19	Measures that increase the organisation's ability to react to unexpected events must be reviewed again on the basis of experience gained from Fukushima.
20	PP20	Transmission of plant parameter data must be re-evaluated with respect to an alternative, independent means of data transmission.
21	PP21	The evacuation concepts must be reviewed, taking account of knowledge gained from the Fukushima accident.
22	PP22	Coordination with other international partners is required to determine whether and how an international network for central international emergency support can be set up.
23	PP23	A review must be carried out to determine whether the necessary information regarding forecasts of releases and radiation exposure is provided in a timely and continuous manner in case of damage.
24	PP24	The following improvement measures were identified regarding information provided to the general public: a It must be ensured not only that the requisite infrastructure and the necessary individuals and/or organisations and equipment are available for crisis communication, but also that the necessary means of communication are in place. The relevant precautions must be taken. Regular training must be provided on the associated procedures. This point also includes a functioning network of experts who are available to the media to supply neutral and objective information. b Review to determine whether the organisational responsibilities for informing the public as well as the local authorities and support staff are clearly stipulated, and are uniformly understood by all involved parties. c A review should be carried out to determine whether the timely communication of radiological effects, including calculated forecasts, is also ensured beyond Switzerland's borders.
25	PP25	It is necessary to examine the extent to which the release of non-nuclear hazardous substances in case of events beyond the design basis could exert an additional influence on the events related to an accident, and which counter-measures are required.
26	PP26	The process of evaluating and examining the applicability of national and international operating experience must be optimised on the basis of knowledge gained from the Fukushima accident.

No	Point designation	Description
27	PP27	It must be guaranteed that the knowledge gained from national and international operating experience (the procedure for processing events) in the licensees' organisations reaches all the relevant individuals and units (including those at group level).
28	PP28	It must be ensured that internationally harmonised assessment scales for nuclear safety are established at the highest level of safety.
29	PP29	Greater importance should also be accorded in the international sphere to the recommendations resulting from international reviews (IRRS, OSART (Operational Safety Review Team)) and from the regular Periodic Safety Reviews (PSR). The transparency of ENSI's supervision and of the operators' safety-related activities must be increased.
30	PP30	ENSI is reviewing the significance of the lessons learned from the Fukushima accident for its supervisory activities.
31	PP31	Additional operational resources must be kept in readiness for radiation protection in case of severe accidents.
32	PP32	It is necessary to examine whether the emission and immission measurements in place on the power plant sites in order to determine the activity releases are guaranteed in case of loss of offsite power (LOOP) or in case of an emergency.
33	PP33	It is necessary to examine the extent to which the availability of the meteorological data required for dispersion calculations is guaranteed in case of extreme natural events.
34	PP34	It is necessary to stipulate arrangements for dealing with contamination in the area surrounding nuclear plants following severe accidents.
35	PP35	It is necessary to examine how to deal with large volumes of contaminated water, radioactive waste or environmentally hazardous substances in case of severe accidents.
36	PP36	As part of the emergency planning for severe accidents, it must be ensured that sufficient radiation protection staff is available on site.
37	PP37	The knowledge gained from the Fukushima accident must be taken into account in the programmes to foster and develop the safety culture in Swiss nuclear power plants.

7.2 List of Open Points for Switzerland from the EU Stress Tests

No	Point designation	Description
38	OP2-1	ENSI will follow up the question as to whether automatic scrams in the Swiss NPPs should be triggered upstream by the seismic instrumentation.
39	OP2-2	With respect to the seismic proof that has still to be supplied, ENSI will follow up, for all Swiss nuclear NPPs, with a more detailed examination of the seismic robustness of the isolation of the containment and the primary circuit.
40	OP2-3	For Gösgen and Leibstadt NPPs, ENSI will continue to follow up measures to improve the seismic resistance of systems for containment venting in case of events beyond the design basis.
41	OP3-1	ENSI will follow up on the impacts of a total debris blockage of hydraulic engineering installations at Gösgen and Mühleberg NPPs.
42	OP4-1	ENSI will follow up on more detailed proof of protection against extreme weather conditions, including combinations thereof.
43	OP5-1	ENSI will follow up on the development of a comprehensive strategy for the targeted deployment of the mobile accident management emergency diesels in order to secure selected direct current or alternating current consumers in the long term under total SBO (or SBO) conditions.
44	OP6-1	For the purpose of risk minimisation, ENSI will follow up on the extent to which the current deployment strategies for the containment venting systems in severe accidents should be retained.
45	OP6-2	ENSI will follow up on whether restoring containment integrity during shutdown in the case of a total SBO represents a time-critical measure.
46	PRT-1	The peer review team recommends considering the assessment of margins with respect to extreme weather conditions exceeding the design bases, e.g. by extending the scope of future PSRs.
47	PRT-2	It is recommended that the regulator assesses the opportunity of requiring more reliance on passive systems for hydrogen management for severe accident conditions. It is also recommended that the regulator considers further studies on hydrogen management for the venting systems.

Part IV: Implementation of activities

8 Summary Tables

8.1 Cross-reference table: ENSREG recommendations and ENSI post-Fukushima actions

Reference	Description	Related Checkpoint or Open Point
ENSREG2.1.	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.	PP1, OP4-1
ENSREG2.2.	The peer review Board recommends that ENSREG underline the importance of periodic safety review. In particular, ENSREG should highlight the necessity to reevaluate natural hazards and relevant plant provisions as often as appropriate but at least every 10 years.	-
ENSREG2.3.	Urgent implementation of the recognised measures to protect containment integrity is a finding of the peer review that national regulators should consider. The measures to be taken can vary depending on the design of the plants. For water cooled reactors, they include equipment, procedures and accident management guidelines to: • depressurize the primary circuit in order to prevent high-pressure core melt; • prevent hydrogen explosions • prevent containment overpressure.	PP5, PP7, PP8, OP6-2
ENSREG2.4.	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.	All PPs OPs and PRTs
ENSREG3.1.1.	To consider the use of a return frequency of 1E-4 per annum (0.1g minimum peak ground acceleration for earthquakes) for plant reviews/back-fitting with respect to external hazards safety cases.	PP1
ENSREG3.1.2.	To consider the possible secondary effects of seismic events, such as flood or fire arising as a result of the event, in future assessments.	PP1
ENSREG3.1.3.	To consider the use of a protected volume approach to demonstrate flood protection for identified rooms or spaces.	PP4
ENSREG3.1.4.	To consider 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.	PP1, OP4-1
ENSREG3.1.5.	To consider the installation of seismic monitoring systems with related procedures and training.	PP1, PP5, OP2-1
ENSREG3.1.6.	To consider 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).	PP4
ENSREG3.1.7.	To consider 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.	PP1, PP4
ENSREG3.1.8.	To consider, in conjunction with recommendation 2.1 and 3.1.7, the formal assessment of margins for all external hazards including, seismic, flooding and severe weather, and identification of potential improvements.	PP1, OP2-2, PRT-1
ENSREG3.2.1.	To consider the provision of alternative means of cooling including alternate heat sinks. Examples include steam generator (SG) gravity alternative feeding, alternate tanks or wells on the site, air-cooled cooling towers or water sources in the vicinity (reservoir, lakes, etc.) as an additional way of enabling core cooling.	PP3, PP12, PP13, PP14

Reference	Description	Related Checkpoint or Open Point
ENSREG3.2.2.	To consider the enhancement of the on-site and off-site power supplies. Examples include adding layers of emergency power, adding independent and dedicated backup sources, the enhancement of the grid through agreements with the grid operator on rapid restoration of off-site power, additional and/or reinforced off-site power connections, arrangements for black start of co-located or nearby gas or hydro plants, replacing standard ceramic based items with plastic or other material that are more resistant to a seismic event. Another example is the possible utilization of generator load shedding and house load operation for increased robustness, however, before introducing such arrangements the risks need to be properly understood.	PP2, PP13
ENSREG3.2.3.	To consider the enhancement of the DC power supply. Examples include improving the battery discharge time by upgrading the existing battery, changing/diversifying battery type (increasing resistance to common-mode failures), providing spare/replacement batteries, implementing well-prepared load shedding/ staggering strategies, performing real load testing and on-line monitoring of the status of the batteries and preparing dedicated recharging options (e. g. using portable generators).	PP2, OP5-1
ENSREG3.2.4.	To consider the implementation of operational or preparatory actions with respect to the availability of operational consumables. Examples include, ensuring the supply of consumables such as fuel, lubrication oil, and water and ensuring adequate equipment, procedures, surveillance, drills and arrangements for the resupply from off-site are in place.	PP2, PP12, PP13
ENSREG3.2.5.	To consider the enhancement of instrumentation and monitoring. Examples include separate instrumentation and/or power sources to enable monitoring of essential parameters under any circumstances for accident management and the ability to measure specific important parameters based on passive and simple principles.	PP5
ENSREG3.2.6.	To consider the enhancement of safety in shutdown states and mid-loop operation. Examples of improvements include, reducing or prohibiting mid-loop operation, adding dedicated hardware, procedures and drills, the use of other available water sources (e. g. from hydroaccumulators), requiring the availability of SGs during shutdown operations and the availability of feedwater in all modes.	-
ENSREG3.2.7.	To consider the use of temperature-resistant (leak-proof) primary pump seals.	PP3
ENSREG3.2.8.	To consider the enhancement of ventilation capacity during SBO to ensure equipment operability.	PP2
ENSREG3.2.9.	To consider 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).	PP10, PP11
ENSREG3.2.10.	To consider the improvement of the robustness of the spent fuel pool (SFP). Examples include reassessment/upgrading SFP structural integrity, installation of qualified and power-independent monitoring, provisions for redundant and diverse sources of additional coolant resistant to external hazards (with procedures and drills), design of pools that prevents drainage, the use of racks made of borated steel to enable cooling with fresh (unborated) water without having to worry about possible recriticality, redundant and independent SFP cooling systems, provision for additional heat exchangers (e. g. submerged in the SFP), an external connection for refilling of the SFP (to reduce the need for an approach linked to high doses in the event of the water falling to a very low level) and the possibility of venting steam in a case of boiling in the SFP.	PP6, PP14
ENSREG3.2.11.	To consider the enhancement of the functional separation and independence of safety systems. Examples include the elimination of full dependence of important safety functions on auxiliary systems such as service water and the introduction of an alternate source of cooling.	PP3
ENSREG3.2.12.	To consider 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.	PP2, PP11, PP16, OP5-1
ENSREG3.2.13.	To consider the provision of mobile pumps, power supplies and air compressors with prepared quick connections, procedures, and staff training with drills. Mobile devices are intended to enable the use of existing safety equipment, enable direct feeding of the primary or secondary side, allow extended use	PP12, PP13, PP15, PP16, OP5-1

Reference	Description	Related Checkpoint or Open Point
	of instrumentation and operation of controls, allow effective fire-fighting, and ensure continued emergency lighting. The equipment should be stored in locations that are safe and secure even in the event of general devastation caused by events significantly beyond the design basis (this also applies to Topic 3 recommendations).	
ENSREG3.2.14.	To consider 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).	PP18, PP19, PP12
ENSREG3.2.15.	To consider the enhancement of the capability for addressing accidents occurring simultaneously on all plants of the site. Examples include assuring preparedness and sufficient supplies, adding mobile devices and fire trucks and increasing the number of trained and qualified staff (this also applies to Topic 3 recommendations).	PP16, PP18, PP12, PP19
ENSREG3.2.16.	To consider the establishment of regular programmes 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.	PP16, PP18, PP12, PP19
ENSREG3.2.17.	To consider the performance of further studies in areas where 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 (this is partially addressed in recommendation 3.2.10). • 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.).	PP1, PP6, PP14 PP2 PP15, PP16
ENSREG3.3.1.	To consider 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. This would include: • Hydrogen mitigation in the containment • Demonstration of the feasibility and implementation of mitigation measures to prevent massive explosions in case of severe accidents. • Hydrogen monitoring system - Installation of qualified monitoring of the hydrogen concentration in order to avoid dangerous actions when concentrations that allow an explosion exist. • Reliable depressurization of the reactor coolant system – Hardware provisions with sufficient capacity and reliability to allow reactor coolant system depressurization to prevent high-pressure melt ejection and early containment failure, as well as to allow injection of coolant from low pressure sources. • Containment overpressure protection - Containment venting via the filters designed for severe accident conditions. • Molten corium stabilization - Analysis and selection of feasible strategies and implementation of provisions against containment degradation by molten corium.	PP28
ENSREG3.3.2.	To consider 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.	PP1, PP15, PP16, OP5-1
ENSREG3.3.3.	To consider 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.	PP15, PP16, OP5-1
ENSREG3.3.4.	To consider, in conjunction with the recommendation 2.4 *(among the European level recommendations)* , the enhancement of SAMGs taking into account additional scenarios, including, a significantly dam-	PP15, PP16, OP5-1

Reference	Description	Related Checkpoint or Open Point
	aged 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.	
ENSREG3.3.5.	To consider the validation of the enhanced SAMGs.	PP15, PP16 OP5-1
ENSREG3.3.6.	To consider exercises aimed at checking the adequacy of SAM procedures and organizational measures, including extended aspects such as the need for corporate and nation level coordinated arrangements and long-duration events.	PP15, PP16 OP5-1
ENSREG3.3.7.	To consider 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.	PP15, PP16, OP5-1
ENSREG3.3.8.	To consider the extension of existing SAMGs to all plant states (full and low-power, shutdown), including accidents initiated in SFPs.	PP15, PP16 OP5-1
ENSREG3.3.9.	To consider 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.	PP9, PP15, PP17, PP20, PP22, PP23
ENSREG3.3.10.	To consider 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.	PP7, OP6-1, PRT-2
ENSREG3.3.11.	To consider the conceptual preparations of solutions for post-accident contamination and the treatment of potentially large volumes of contaminated water.	PP34, PP35
ENSREG3.3.12.	To consider the provision for radiation protection of operators and all other staff involved in the SAM and emergency arrangements.	PP18, PP31
ENSREG3.3.13.	To consider 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.	PP10, PP11
ENSREG3.3.14.	To consider 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.	PP18, PP19, PP31
ENSREG3.3.15.	To consider 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 prioritizing 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.	-
ENSREG3.3.16.	To consider the performance of further studies to improve SAMGs. Examples of areas that could be improved with further studies include: • The availability of safety functions required for SAM under different circumstances. • Accident timing, including core melt, reactor pressure vessel (RPV) failure, basemat melt-through, SFP fuel uncovery, etc. • PSA analysis, including all plant states and external events for PSA levels 1 and 2. • 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. • Core cooling modes prior to RPV failure and of re-criticality issues for partly damaged cores, with un-borated water supply. • Phenomena associated with cavity flooding and related steam explosion risks. • Engineered solutions regarding molten corium cooling and prevention of basemat melt-through. • Severe accident simulators appropriate for NPP staff training.	PP16

8.2 Cross-reference table: recommendations resulting from CNS 2nd Extraordinary Meeting and ENSI post-Fukushima actions

Reference	Description	Related Checkpoint or Open Point
CNS-EOM1	Take the IAEA Safety Standards into account in enhancing nuclear safety.	PP29
CNS-EOM2	Include information in its report under the Convention on Nuclear Safety (National Report) about how it has taken or intends to take the IAEA Safety Standards (including, in particular, the Safety Fundamentals and Requirements) into account in implementing its obligations under the Convention on Nuclear Safety.	PP29
CNS-EOM3	Ensure that its regulatory body is effectively independent in making regulatory judgments based on scientific and technological grounds and taking enforcement actions and that it has functional separation from entities having responsibilities or interests, such as the promotion or utilisation of nuclear energy (including electricity production), that could conflict with safety or other important regulatory objectives or otherwise unduly influence the decision making of the regulatory body.	PP30
CNS-EOM4	Ensure the effectiveness of its regulatory body by providing for adequate legal authority, sufficient human and financial resources, staff competence, access to necessary external expertise for its decision-making based on adequate scientific and technical knowledge, access to international cooperation, and other matters needed for fulfilling its responsibilities for the safety of nuclear installations.	PP29, PP30
CNS-EOM5	Ensure that its regulatory body requires a licensee for a nuclear installation to have adequate expertise and resources to fulfill its responsibility for the safe operation of the nuclear installation, including effective response to any accident and mitigation of its consequences.	PP29, PP31, PP36, PP37
CNS-EOM6	Ensure that its regulatory body operates in a transparent and open manner, taking into account legitimate concerns over security and other sensitive interests that might be adversely affected by the public disclosure of particular information.	PP29, PP30
CNS-EOM7	Include information in its National Report on its efforts to ensure the independence, effectiveness and transparency of its regulatory body.	PP29
CNS-EOM8	Host, as appropriate, an international peer review mission of its regulatory framework governing the safety of nuclear installations, if the Contracting Party has an operating nuclear installation.	PP29
CNS-EOM9	Host regularly, as appropriate for the size and number of the nuclear installations within that Contracting Party, international peer review missions of the operational safety of its nuclear installations, if the Contracting Party has an operating nuclear installation.	PP29
CNS-EOM10	Host international peer review missions on integrated nuclear infrastructure and other relevant matters, including site and design safety reviews prior to commissioning its first nuclear installation,	-
CNS-EOM11	Include information in its National Report on any international peer review missions under paragraph 1, 2 or 3 of this section that the Contracting Party has hosted in the period between two review meetings of the Contracting Parties including a summary of the findings, recommendations and other results of the missions, actions taken to address these results, and plans for follow-up missions.	PP29
CNS-EOM12	Make its National Report and any written questions and responses relating to that report publicly available, with the exception of any particular item of information that would adversely affect security or other sensitive interests if publicly disclosed and request the IAEA to maintain this information, other than any information covered by the above exception, on a website open to the public.	PP29
CNS-EOM13	Make any international peer review mission reports, any follow-up reports or any national responses to such reports publicly available, with the exception of any particular items of information that would adversely affect security or other sensitive interests if publicly disclosed and request the IAEA to maintain this information, other than any information covered by the above exception, on a website open to the public.	PP29
CNS-EOM14	Include information in its National Report on its efforts to enhance openness and transparency in the implementation of its obligations under the Convention on Nuclear Safety.	PP29
CNS-EOM15	Enhance the robustness of the peer review of national reports submitted under the CNS through the preparation and submission of thorough reports that present successes and challenges and the frank discussion of these reports.	PP29

List of acronyms

AC	Alternating Current
AM	Accident Management
AMM	Accident Management Measures
BDB	Beyond Design Basis
BIP	Basic Inspection Programme
CNS	Convention on Nuclear Safety
CNS EOM	Convention on Nuclear Safety 2nd Extraordinary review Meeting
DC	Direct Current
DETEC	Department of Environment, Transport, Energy and Communication
EAL	Emergency Action Level
DG	Diesel Generator
EC	European Commission
ECC	Emergency Control Centre
ECR	Emergency Control Room
ECURIE	European Community Urgent Radiological Information Exchange
EMERCON	early notification system for nuclear emergencies operated by the IAEA and based on the Convention on Early Notification of a Nuclear Accident
ENEF	European Nuclear Energy Forum
ENSI	Swiss Nuclear Safety Inspectorate
ENSRA	European Nuclear Security Regulators Association
ENSREG	European Nuclear Safety Regulators Group
EPRI	Electric Power Research Institute
ER	Emergency Room
ERO	Emergency Response Organisation
EU	European Union
HERCA	Heads of the European Radiological protection Competent Authorities
HOF	Human and Organisational Factors
IAEA	International Atomic Energy Agency
IDA NOMEX	inter-departmental working group to review emergency preparedness measures in case of extreme events in Switzerland
IEC	Incident and Emergency Centre
INES	International Nuclear and Radiological Event Scale
INEX	International Nuclear Emergency Exercises
IRRS	Integrated Regulatory Review Service
IRRT	International Regulatory Review Team (former IRRS)
IRS	International Reporting System for Operating Experience
LOOP	Loss Of Off-site Power
MADUK	Monitoring network for automatic dose rate measurements in the vicinity of nuclear power plants
MCR	Main Control Room
NAcP	National Action Plan
Nagra	National Cooperative for the Disposal of Radioactive Waste
NBCN	Nuclear Biological Chemical Natural
NEA	Nuclear Energy Agency of the OECD
NEO	Swiss Nuclear Energy Ordinance
NEOC	National Emergency Operations Centre
NPP	Nuclear Power Plant

NSC	Federal Nuclear Safety Commission
NSGC	Nuclear Security Guidance Committee
NUSSC	Nuclear Safety Standards Committee
OBE	Operating Basis Earthquake
OECD	Organisation for Economic Co-operation and Development
OP	Open Point
OSART	Operational Safety Review Team
PAR	Passive Autocatalytic Recombiner
POLYCOM	radio-based communication network
PP	Checkpoint
PRP	PEGASOS Refinement Project
PRT	Peer Review Team
PSA	Probabilistic Safety Assessment
PSR	Periodic Safety Reviews
RANET	IAEA Response and Assistance Network
RASSC	Radiation Safety Standards Committee
RHWG	Reactor Harmonization Working Group
RPV	Reactor Pressure Vessel
SAM	Severe Accident Management
SAMG	Severe Accident Management Guideline
SBO	Station Black Out
SER	Substitute Emergency Room
SFOE	Swiss Federal Office of Energy
SFP	Spent Fuel Pool
SG	Steam Generator
SSE	Safety Shutdown Earthquake
SSHAC	Senior Seismic Hazard Analysis Committee
Swisstopo	Swiss Federal Office of Topography
TFNPP	Technical Forum on Nuclear Power Plant
TFS	Technical Forum on Safety
TRANSCC	Transport Safety Standards Committee
USIE	Exchange in Incidents and Emergencies
WANO	World Association of Nuclear Operators
WASSC	Waste Safety Standards Committee
WENRA	Western European Nuclear Safety Regulators Association
WGIP	OECD/NEA Working Group on Inspection Practices
WGOE	OECD/NEA Working Group on Operating Experience

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