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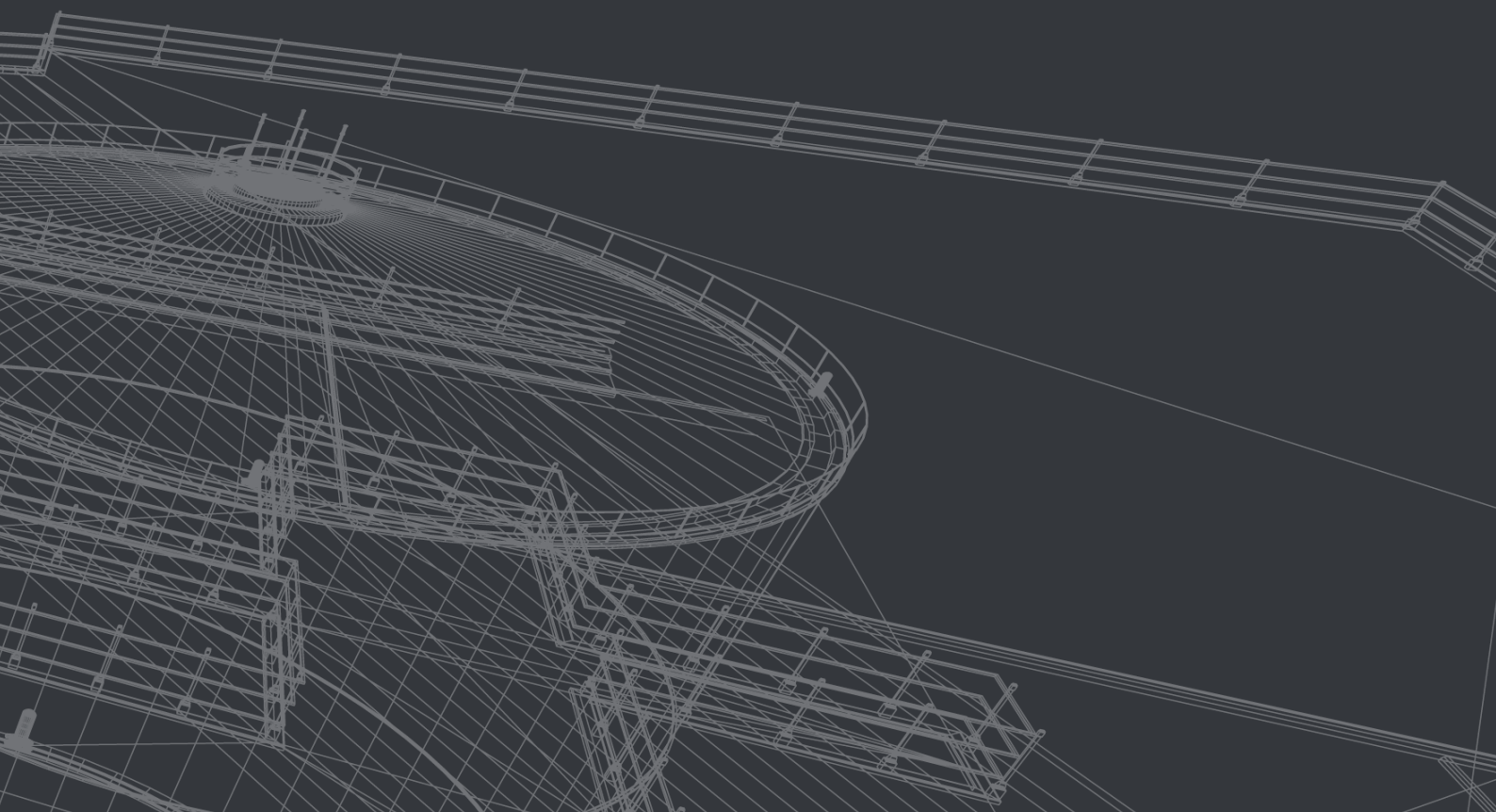
Swiss Federal Nuclear Safety Inspectorate ENSI

Action Plan Fukushima 2013



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1 Introduction

Immediately after the reactor accidents at the Fukushima Dai-ichi nuclear power plant in Japan on 11 March 2011, ENSI initiated measures to review the safety of Switzerland's nuclear power plants. These measures were contained in four formal orders issued by ENSI. The first three formal orders (dated 18 March, 1 April and 5 May 2011) called for immediate measures and supplementary analyses.

The immediate measures comprised the construction of a joint external emergency storage facility for the Swiss nuclear power plants, including the necessary plant-specific hook-up points for Accident Management (AM) equipment, and backfits to provide external injection into the spent fuel pools. The additional reassessments focused on the design of the Swiss nuclear power plants against earthquakes, external flooding and a combination thereof. Screening investigations were also requested regarding the coolant supply for the safety and auxiliary systems and the spent fuel pools.

In parallel with these investigations by the licensees, ENSI itself conducted topical inspections during 2011, entailing reviews of the cooling systems already in place for spent fuel pools, protection against external flooding and systems for filtered containment venting. These topical inspections were continued during 2012: they included the plants' strategies in case of a prolonged loss of power supply, processes for the assessment of external occurrences, and the emergency rooms available in the Swiss plants.

The results of ENSI's reviews confirmed that the Swiss nuclear power plants 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. The safety case has been demonstrated for all the analysed accidents on the basis of the hazard assumptions that are currently applicable. This means that compliance with the basic statutory requirements for fulfilling the fundamental safety functions (reactivity control, cooling of the fuel elements and confinement of radioactive substances) is guaranteed. In order to continue improving safety, however, ENSI has stipulated a series of additional requirements for substantial backfits, e.g. a requirement for a flood-proof and earthquake-resistant diversified ultimate heat sink. ENSI is supervising the work carried out by the nuclear power plants to meet these requirements in the course of its ongoing supervisory activities, either by drawing up reviews, issuing permits or carrying out on-site inspections and checks.

In its fourth formal order issued on 1 June 2011, ENSI requested the licensees to take part in the EU stress tests. ENSI reviewed the documentation for the EU stress test submitted by the licensees in the Swiss country report on the EU stress tests (ENSI-AN-7798 dated 31 December 2011). On 10 January 2012, further formal orders were issued requiring clarification of three major open points arising from the analysis of the final reports by the Swiss nuclear power plants for the EU stress tests. Switzerland's submissions for the EU stress tests then underwent a peer review process. The results of the peer review at European level confirm ENSI's conclusions regarding the safety of Swiss nuclear power plants, and they also provide an overview of the condition of plants in Europe. ENSI is currently implementing the two recommendations made by the peer review team for Switzerland, which relate to scenarios beyond the design basis. In addition, ENSI is participating in the follow-up work on the EU stress tests in order to track implementation of the recommended measures in Europe, and it is actively collaborating on the optimisation of the WENRA Safety Reference Levels.

In parallel with the activities mentioned above, ENSI published four reports during 2011 in relation to the event analysis of the Fukushima accident:

- Fukushima sequence 11032011, Event Sequences at Fukushima Dai-ichi and Dai-ni following the Tohoku-Chihou-Taiheiyou-Oki Earthquake on 11.03.2011, ENSI-AN-7614 Rev. 1 (26 August 2011)
- Fukushima analysis 11032011, In-depth Analysis of the Accident at Fukushima on 11 March 2011, With Special Consideration of Human and Organisational Factors, ENSI-AN-7669 (29 August 2011)
- Fukushima lessons 11032011, Lessons Learned and Checkpoints based on the Nuclear Accidents at Fukushima, ENSI-AN-7746 (29 October 2011)
- Fukushima impact 11032011, Radiological Effects of the Nuclear Accidents at Fukushima on 11.03.2011, ENSI-AN-7800 (16 December 2011)

The knowledge obtained from analysing the events of the accident at Fukushima was reviewed to determine its applicability to Switzerland, and a summary was compiled in the ENSI report entitled "Lessons Learned" in the form of a series of checkpoints. Further points were added on completion of the analyses for the EU stress tests. The current overview can be found in Annexes 1 and 2. The list of points identified is reviewed continuously on the basis of the latest findings and is updated as necessary (see the comments on this aspect in section 2). Processing of the checkpoints will probably be completed by 2015.

The Mühleberg nuclear power plant (KKM) intends to carry out the backfits ordered on the basis of Fukushima and those required for the purposes of long-term operation within the overall DIWANAS project. ENSI has reviewed this overall project with respect to long-term operation and has requested that both the backfits ordered due to Fukushima and those required for long-term operation should be implemented with a staggered schedule by the end of the 2017 annual refuelling and maintenance outage, at the latest. A detailed planning for the implementation of these backfits must be submitted to ENSI by 30 June 2013.

The Fukushima action plans serve the purpose of ensuring transparency as regards processing of the identified points until they are implemented. They also provide an instrument for the planning of supervisory work and the assessment of new knowledge gained from the Fukushima accident. Progress with processing the identified points is documented and published. The action plan itself is updated by February of the year in progress by identifying key issues for that year. ENSI's annual reporting also provides information about the processing status. Beyond that, the public may be informed on specific issues should the need arise.

ENSI report	**Publication**
Fukushima Action Plan	February
Oversight Report, Radiological Protection Report, Research and Experience Report	April - June
National Action Plan for Follow-Up to the EU Stress Tests	December

2 Reports relating to Switzerland

2012 saw the publication of four reports regarding the situation in Switzerland, which are detailed in the following subsections. These are: the report on Fukushima by the Federal Nuclear Safety Commission (NSC) , the report by the EU stress tests peer review team for Switzerland, the report by the Environment Agency Austria (Umweltbundesamt GmbH) on the Mühleberg nuclear power plant, and the report by the Öko-Institut (Institute for Applied Ecology, Darmstadt, Germany) on the Beznau nuclear power plant.

2.1 Report by the NSC: "The Fukushima reactor catastrophe - follow-up measures in Switzerland"

In its report published in March 2012, the NSC provides an overview of the events at Fukushima and the formal orders which ENSI then issued in Switzerland. For this purpose, the NSC sets the accident in the context of the fundamental safety concept for nuclear power plants and in summary reaches the conclusion that ENSI's action list is an appropriate and comprehensive means of learning the lessons that may be drawn for nuclear power plants in Switzerland. The NSC considers that the schedule set by ENSI for reviews and measures imposes very demanding requirements on the licensees and on ENSI itself.

The NSC sets out seven formal recommendations which ENSI has added to the action plans. The NSC report also contains various suggestions which ENSI is incorporating into its ongoing supervisory activities.

Detailed comments on the NSC's recommendations are given below.

The effectiveness of internal emergency preparedness measures (defence-in-depth level 4) should be reviewed at regular intervals. Such reviews should take more account of combinations of events and possible follow-on events. (NSC recommendation 4.3)

The NSC's report makes specific reference to natural events beyond the design basis, in respect of which the adequacy of internal emergency preparedness measures should be reviewed. ENSI recognises the special significance that extreme natural events have acquired in the light of Fukushima, and has already assessed the margins available at the Swiss nuclear power plants by participating in the EU stress tests. Further analyses will focus on improving safety margins and emergency management in case of severe accidents as key issues in 2013 (see sections 4.4 and 4.6). Extreme drought was also listed as a case to be considered in connection with proof for extreme weather conditions (see section 3.3).

As regards current conditions in Switzerland, it should be noted that the internal emergency preparedness measures at *defence-in-depth* level 4 are mapped and evaluated in the probabilistic safety analyses. These analyses also take account of all potential combinations of subsequent errors which could lead to core damage. Combinations of triggering events are also taken into consideration for the definition of the deterministic accident spectrum. In 2012, for instance, ENSI assessed the proof submitted by the licensees of the Swiss nuclear power plants for the combination of a 10,000-year earthquake and earthquake-induced flooding.

Guideline ENSI-B11 ("Emergency exercises") already states that staff emergency exercises should generally be conducted for scenarios beyond the design basis where possible. Furthermore, in compliance with the requirements in Guideline ENSI-B12 ("Emergency preparedness in nuclear installations"), written plant-specific technical decision-making aids (Severe Accident Management Guidance (SAMG)) should be available in every plant to mitigate the effects of a severe accident. These documents have undergone a SAMG validation exercise and are included in regular training activities. Knowledge gained from the exercises and training activities is taken into account when the SAMG is updated. Regular reviews of the SAMG are carried out as part of the Periodic Safety Review (PSR) which takes place at least once every ten years.

The investigations to determine the seismic hazard for the Swiss nuclear power plants (PEGASOS Refinement Project) must be brought to a prompt conclusion, and the applicable seismic hazards must be defined by ENSI. (NSC recommendation 5.1.1)

According to the current schedule, the "PEGASOS Refinement Project" will be completed in 2013. ENSI will then carry out a final review of the project results and will redefine the seismic hazard assumptions to be used in the safety case. The definition of the methodology for the demonstration of the safety case has already been added as a key issue for 2013 (see section 4.1).

New knowledge regarding the flooding hazard, e.g. studies on historic hydrology, must be taken into account for the periodic safety reviews. (NSC recommendation 5.1.2)

According to the "Hazard assumption ordinance" (SR [Systematic Collection of Federal Law] 732.112.2 article 5, paragraph 3), historic data acquired through current scientific knowledge have to be considered in order to determine the hazards. When available and applicable, data of this sort was also used for the latest safety case demonstration regarding the 10,000-year flood, drawn up in 2011 for the Swiss nuclear power plants' sites. Furthermore, the hazard due to debris blockages was assessed in detail. For this purpose, ENSI ordered additional investigations which are being followed up in the course of ongoing supervisory activities (see section 3.2).

In ENSI's view, a high technological level (as compared to other countries) has already been attained in the analysis of the flooding hazard for Swiss nuclear power plants. Further refinements to these analyses are possible, in particular including greater use of coupled hydraulic-sedimentological 2-D calculations for specific scenarios and a more extensive evaluation of historic floods. However, the latter requires research work. ENSI intends to encourage development work of this sort.

In order to strengthen provisions for a prolonged loss of AC power supply, there should be a review of the optimisation potential for extending battery lifetimes obtained from targeted management of consumer loads in connection with emergency preparedness measures. (NSC recommendation 5.1.3)

During the fourth quarter of 2012, ENSI carried out inspections in all the plants focusing on the issue of "Control of a prolonged loss of AC power supply" (station blackout, SBO). Among other aspects, these inspections also considered the supply of direct current for key consumers by means of batteries. Assessment of the results of these inspections has not yet been completed. ENSI endorses the NSC's recommendation and will also review the optimisation measures planned by the plants to extend battery lifetimes as part of its review of the measures to bring an SBO under control.

Control of fully developed rapid hydrogen production in the Swiss nuclear power plants must be reviewed. As a potential strategy, filtered venting should be optimised with the help of the following measures :

- *Adequate numbers of accident-proof devices should be installed at relevant locations in the primary containment in order to measure hydrogen and oxygen concentrations. Both measured variables should be taken as criteria for triggering early filtered venting in order to prevent the formation of ignitable gas mixtures to a potentially damaging extent.*
- *In the light of the events at Fukushima, it is necessary to review and ensure the error-proof operation of filtered venting under more difficult conditions (including more severe radiological conditions) by remote control and, if necessary, by local manual actions.*
- *The procedures for filtered venting must be defined in advance. The decision-making pathways for this purpose must be specified so that authorisation is obtained promptly, even under more difficult conditions.*

In addition, the NSC advises reviews of the following aspects: situations in which hydrogen can escape into adjacent rooms, the hazard that this would create and the measures which could be used to bring it under control, where necessary. (NSC recommendation 5.2.1)

ENSI immediately re-addressed the issues of hydrogen management and filtered venting in the aftermath of Fukushima. On the one hand, analyses regarding the release and control of hydrogen in the spent fuel pool buildings were ordered in May 2011, and ENSI completed its assessment of these analyses in February 2013 (see section 3.6). On the other hand, ENSI has critically analysed the information supplied by the licensees for the reviews in connection with the EU stress tests, as well as other data. Related open points which call for in-depth consideration were identified and gradually incorporated into the processing work. ENSI stipulated new requirements regarding hydrogen management for all plants in the first quarter of 2013. The topics of hydrogen control and containment integrity are key issues for 2013: the planned activities cover all of the individual aspects raised by the NSC (see sections 4.2 and 4.5).

The NSC recommends that the concept of the external storage facility for operational resources should be validated and optimised as necessary by means of exercises, in order to ascertain the prompt availability of the materials required. (NSC recommendation 5.2.2)

ENSI is entirely in agreement with the NSC that the procedures for the external storage facility can only be validated by deployments that simulate actual practice. ENSI's activities are described in section 4.6.

In case of an accident or an accident, ENSI is responsible for the task of assessing the licensees' procedures. For this purpose, the emergency situation and the adequacy of the measures must undergo constant assessment, independently of the licensees. Suitable means should be in place to ensure these capabilities on a permanent basis. (NSC recommendation 5.4)

ENSI has a broad-based emergency preparedness organisation which integrates all the specialist disciplines required in order to assess malfunctions and accidents in nuclear power plants. In case of a deployment, the measures initiated by the plants must be assessed quickly for the purpose of protecting the population.

The International Atomic Energy Agency (IAEA) is currently proposing amendments to the General Safety Requirements, GSR Part 1, " Governmental, Legal and Regulatory Framework for Safety", which would cover (among other aspects) the adequacy of training and practice for all players involved in an emergency, and maintenance of the emergency preparedness organisation over a prolonged period. In this context, ENSI is examining whether further measures are required for its own emergency preparedness organisation.

2.2 EU stress tests: peer review team report for Switzerland

The peer review team, which consists of international experts, has carried out a review of the information provided by Switzerland in connection with the EU stress tests (information is available in the country report for Switzerland on the EU stress tests, ENSI-AN-7798 dated 31 December 2011, and in the reports by the Swiss licensees). During the so-called topical review the experts made topic-related cross-comparisons with other countries. The review was completed by a so-called country review with a discussion of the open points and a visit to the Beznau nuclear power plant. The peer review team identified two issues as offering potential for improvements. It is recommended that further progress should be made in the determinination of the margins for extreme weather conditions, i.e. the safety reserves with respect to hazards in the range beyond the design basis, for example in the course of the periodic safety reviews.

ENSI has followed this recommendation and has defined a key issue for 2013, starting with hazards in the design range (see sections 3.3 and 4.3). In connection with hydrogen management, the peer review team also commented that the use of passive systems in case of severe accidents should be reviewed, as well as the behaviour of hydrogen in the venting system pipes. These specific aspects addressed in the second recommendation have been incorporated into the "Hydrogen management" key issue (see section 4.5).

2.3 Assessment of the Mühleberg nuclear power plant by the Environment Agency Austria (Umweltbundesamt GmbH)

The Environment Agency Austria (Umweltbundesamt GmbH) has drawn up a technical assessment report on behalf of the Federal Ministry for Agriculture and Forestry, Environment and Water Management, which is the competent authority in this regard. The report covers technical safety aspects of the Mühleberg nuclear power plant (KKM) "...which, from the Austrian viewpoint, require in-depth bilateral discussion". ENSI has reviewed the report and has issued a statement on it for the attention of the coordinating office in Switzerland of the bilateral Austrian-Swiss committee. ENSI was unable to identify any new aspects in connection with the safety issues that were raised. The question of requirements for equipment to deal with severe accidents is addressed in the context of the present Action Plan 2013 (see section 4.4).

2.4 Expert report by the Institute for Applied Ecology, Darmstadt: analysis of the results of the EU stress tests for the Fessenheim and Beznau nuclear power plants, part 2: Beznau

On behalf of the Baden-Württemberg Ministry of the Environment, Climate Protection and the Energy Sector, the German Institute for Applied Ecology (Ökoinstitut) has drawn up an assessment of the results from the EU stress tests for the Fessenheim and Beznau nuclear power plants, which are located close to the border. For this purpose, the Institute for Applied Ecology proceeded according to the investigative method of the German Reactor Safety Commission (RSC) which was applied in parallel with the EU stress test in Germany, and on the basis of the specific additional studies for the States of Baden-Württemberg and Bavaria. For the assessment of the Fessenheim and Beznau plants, these methods are therefore based on specific German safety standards.

The approach adopted by the Institute for Applied Ecology focused on the robustness of the systems that are permanently installed in order to perform safety functions. In ENSI's view, the technical characteristics of the permanently installed safety systems at the Beznau plant are presented correctly in the report for the most part, and the results of the assessment (based on a comparison with specific German safety requirements) are essentially correct. However, the results of the comparison did not provide ENSI with any new knowledge. In response to the criticism made that the maintenance criterion (according to German requirements) is not met, it must be stated that no maintenance may be carried out on Swiss nuclear power plants during normal operation if the maintenance criterion is not met. In the latter case, there is consequently no need to assume for accident analyses that maintenance is performed.

Furthermore, the report by the Institute for Applied Ecology only gives reduced consideration to the wide-ranging preventive and mitigative Accident Management measures implemented at the Beznau nuclear power plant. The consideration given to level 4 of the defence-in-depth concept is therefore inadequate. Until recently, German safety requirements focused on the safety equipment at level 3 of the defence-in-depth concept, whereas the Swiss safety regulations have for a long time required the plants to comply with high standards at all defence-in-depth levels. Consequently, the expert report by the Institute for Applied Ecology does not provide a complete picture of the Beznau nuclear power plant's ability to withstand accidents beyond the design basis.

3 Retrospective of 2012

3.1 Earthquakes

By the end of March 2012, in accordance with the specified deadline, the Swiss nuclear power plants supplied ENSI with their safety case demonstrating adequate protection against a 10,000-year earthquake and a combination of earthquake and flooding, as required by the formal order dated 1 April 2011. Seismic fragilities for all the relevant structures, systems and components had already been determined in advance. In addition to analyses of the safety of the nuclear reactor, the primary circuit and the containment, ENSI's formal order dated 5 May 2011 also required design reassessments of the spent fuel pools, their buildings and cooling systems, and proof of compliance with the permitted dose limits for these accidents. In their deterministic proof, the plants demonstrated that such accidents are safely terminated in compliance with the boundary conditions stipulated by ENSI, and that a value lower than the permitted limit of 100 mSv as per the Radiological Protection Ordinance (SR 814.501) is attained. Based on its review of the submitted documentation, ENSI concluded that core cooling and cooling of the spent fuel pools is guaranteed under the impact of a 10,000-year earthquake and a combination of earthquake and seismically induced flooding, in compliance with the single failure criterion. The dose limit of 100 mSv is respected during such accidents. The criterion as per article 3 of the "DETEC Ordinance on the Methodology and Boundary Conditions for Checking the Criteria for the Provisional Shut-Down of Nuclear Power Plants" (SR 732.114.5) is not met. In ENSI's statements on the seismic safety case that was submitted, additional requests were identified; these relate in general to individual components in the nuclear installations for which more detailed analyses are required or whose seismic behaviour can be improved by minor structural adaptations. All the additional requests were incorporated into individual follow-on tasks so that their processing will continue as part of the normal supervisory activities.

The licensees of the nuclear power plants at Beznau (KKB), Leibstadt (KKL) and Mühleberg (KKM) submitted the results of their assessments of the seismic robustness of the containment's and primary circuit's isolation in line with the deadline of 30 September 2012. ENSI granted the licensee of the Gösgen nuclear power plant (KKG) an extension of the deadline for submission of the supplementary assessment until 31 December 2012, and the documentation was submitted in compliance with this new deadline. The licensees conclude that the integrity of the primary circuit and the containment is guaranteed on the basis of the seismic hazard assumptions defined in ENSI's formal order of 1 April 2011.

ENSI carried out a cursory examination of the assessment reports on seismic robustness submitted by the licensees. As regards KKB, it can be stated that the seismic robustness of the isolation of the containment and the primary circuit was already covered by the seismic safety case requested in ENSI's formal order dated 1 April 2011, which KKB submitted by 31 March 2012 and which was reviewed and accepted by ENSI. For the other nuclear power plants, the review of the seismic robustness of the containment isolation (in particular) must also include additional buildings and items of equipment which are not covered by the seismic safety case submitted by 31 March 2012 and belong now to the scope of the analysis.

3.2 Flooding

In its formal order dated 1 April 2011, ENSI required all the Swiss nuclear power plants to submit their safety case demonstrating adequate protection against the 10,000-year flood. After submittal the safety case was reviewed by ENSI. In its statements, ENSI concluded that all the plants can be brought into a safe condition even if the external power supply fails at the same time. The applicable does limits are respected by all the plants. In connection with the analyses of seismically induced flooding, ENSI identified new requests in 2012, although they do not cast doubt on the overall result of that review. In order to complete its analyses regarding seismically induced flooding, the Gösgen nuclear power plant (KKG) must consider the effects of a failure of the dam installations located upstream in the relevant area surrounding the KKG. The Mühleberg nuclear power plant (KKM) must complete the seismic safety calculations for dam installations in the power station's zone of influence in accordance with the requests contained in the review reports of the Swiss Federal Office of Energy (SFOE). KKM submitted the requested documents by the deadline. The relevant statement by the authorities is expected in the first quarter of 2013.

In connection with the Swiss country report on the EU stress tests, ENSI asked KKG and KKM to consider flood-induced debris blockages of hydraulic engineering installations by means of a sensitivity study of accident scenarios beyond the design basis. KKB had already submitted documentation on this aspect and it submitted a revised version based on coupled water/sediment calculations (hydraulic-sedimentological 2-D calculations) in 2012. Due to its elevated location, KKL is not affected by any debris blockages. In ENSI's view, the studies available from KKB, KKG and KKM indicate that debris blockages cannot trigger a cliff-edge effect for these plants. On the basis of ENSI's statement on long-term operation, KKM was requested to analyse the safety margins for flooding in greater detail (see the "Safety evaluation report on the long-term operation of the Mühleberg nuclear power plant", ENSI 11/1700 dated 20 December 2012). ENSI has requested further information for a conclusive assessment of the situation at the Gösgen and Beznau nuclear power plants. Work still outstanding was incorporated by ENSI into individual follow-on tasks so that their processing will continue as part of the normal supervisory activities.

In ENSI's view, the technological standard attained for the analysis of the flooding hazard at Swiss nuclear power plants is already high when compared to other countries. Additional refinements of these analyses are possible, but they should be supported by research results. This applies in particular to the assessment of historic flooding and the extended use of coupled hydraulic-sedimentological 2-D calculations for specific scenarios. Furthermore, ENSI advocates the initiation with other Federal authorities of a research project on the flooding hazard for the catchment area of the Aare, into which the results of the development work should be incorporated.

3.3 Extreme weather conditions

In its letter to the licensees dated 4 July 2012, ENSI specified the requirements for the probabilistic hazard analyses and the safety case needed to demonstrate adequate protection of the plant against extreme weather conditions.

Quantitative analyses must be carried out for the hazards of extreme winds, tornados, extreme air and river water temperatures, heavy rainfall on the plant site and deep snow.

On the other hand, the following hazards may be given qualitative treatment provided that their impact on the plant does not result in a demand for safety systems: hail, freezing rain, drought (i.e. low river and groundwater levels), forest fire, icing caused by low outdoor or river water temperatures, and combinations of:

- exceptionally harsh winter conditions with snow (snowdrifts), low temperatures and icing; and
- extremely acute summer conditions with high temperatures, drought, forest fires and low river and/or groundwater levels.

The design values of the structures (buildings) and equipment (e.g. exhaust stacks of emergency diesel generators, air intakes, etc.) required to cope with the hazard in question must be presented so as to prove that the plant has adequate protection. It must also be demonstrated that they can withstand the expected loads. If the resultant loads are covered by other load cases, such cases may be adduced in order to provide proof. The margins in relation to the design values must also be indicated.

The concept for proving adequate protection against extreme weather conditions was submitted by the licensees by the end of 2012 in accordance with the deadline. Due to the large number of analyses, the licensees were granted one more year for completing the assessment than was envisaged in the Action Plan 2012.

3.4 Prolonged loss of power supply (Station Blackout, SBO)

ENSI conducted team inspections in all plants during the fourth quarter of 2012 in order to review the precautionary measures to cope with a prolonged loss of AC power supply (Station Blackout, SBO).

The purpose of these inspections was to review the strategies in place at the plants for coping with an SBO accident beyond the design basis, the Accident Management (AM) resources available to terminate the accident, the hook-up points for emergency supply of cooling water and electricity, and the emergency procedures relating to an SBO. After technical discussions on the plant-specific strategies and the situation regarding time and resources, the planned operational resources such as mobile AM emergency power units, pumps, fire water trucks and motorised sprays, as well as their storage and deployment locations, were assessed on the basis of an inspection walkdown of the plants. The presence and accessibility of feed and hook-up points under SBO conditions were also checked. In addition, the scope of the inspections included a review of the necessary quantities, and those held in readiness, of service products such as diesel fuel and lubricating oil in order to guarantee operation of AM equipment for seven days, and the stocks held of other auxiliary materials such as cables, plugs and transportation facilities for equipment, as well as tanks for local

refilling.

The inspections demonstrated that the plants have effectively continued to develop their existing strategies, and that adequate AM resources are available to prevent core damage after an SBO. The results of the inspections will also be assessed in detail during the first quarter of 2013. Depending on the results of the assessment, ENSI will decide whether further actions are required in addition to the measures regarding SAM equipment already stipulated for the Action Plan 2013 (see section 4.4).

3.5 Loss of ultimate heat sink

In order to meet the requirements arising from ENSI's formal order dated 5 May 2011, KKM submitted an application for "permit of concept" by the stipulated deadline of 30 June 2012. This application covers three back-fitting projects which should be combined to deliver an overall solution (the DIWANAS project).

Among other activities, the DIWANAS project includes the construction of an alternate (diverse) ultimate heat sink to the river Aare. According to the "permit of concept" application, a feed pipe from a groundwater intake in the Saane valley will be added to the SUSAN special emergency system. Should the Aare not be available, this will serve as a heat sink to ensure the removal of residual heat from the reactor and the spent fuel pool. The transfer point for the feed pipe from the groundwater intake in the Saane valley will be located in a new building to be constructed on the power plant site.

ENSI has carried out first a cursory review of the submitted application documents. ENSI considers that the proposed concept for the Saane groundwater intake is basically suitable in order to meet the requirement for an alternate, diverse cooling water supply. The additional supply of cooling water can be operated independently of the existing river water supply (from the Aare) and should be protected against a 10,000-year earthquake and a 10,000-year external flood. The cursory review yielded some further requests regarding additional documents to be submitted. These documents were submitted by KKM in mid-December 2012, in compliance with the specified deadline, and were taken into consideration by ENSI when it issued the "permit of concept" at the end of January 2013.

As regards scheduled dates for the implementation of measures included in the DIWANAS project, ENSI requested (in its statement on the long-term operation of KKM) that the backfits covered by the DIWANAS project must be implemented at the latest by the end of the 2017 annual refuelling and maintenance outage, and a binding implementation plan for this purpose must be submitted by 30 June 2013.

3.6 Containment venting and hydrogen management

Provisions against the hazard caused by hydrogen were taken into account in the design of Swiss nuclear power plants at an early stage. Various aspects of these provisions were reviewed again in the light of events at Fukushima.

Relevant work during 2012 focused on investigations of protective measures against the hydrogen

hazard in the spent fuel pools, the seismic resistance of the containment venting systems and the follow-up activities arising from the inspections regarding containment venting. The status of the relevant work is presented in brief below.

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 concluded that the quantities of hydrogen produced by radiolysis are not sufficient to generate an ignitable mixture in the area of the spent fuel pools. The investigations also show that in the event of a 10,000-year earthquake/flood combined with a loss of the emergency power supply, at least three days are available to initiate appropriate measures in all the plants. In ENSI's view, prevention takes precedence over mitigation and, for this reason, ENSI has imposed specific additional requirements for each plant to ensure monitoring of the spent fuel pools, upgrading of the spent fuel pool 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 spent fuel pools.

The Gösgen and Leibstadt nuclear power plants have submitted their studies regarding the seismic resistance of the containment venting systems together with proposals for improvements, if needed.

The requests identified during the topical inspection of filtered containment venting have been processed by the licensees and analyses have been submitted to ENSI. In this regard, KKG submitted the required concept for improvements to displays in the emergency control room, and KKB updated the Post-LOCA study on the investigation of radiation exposure at workplaces in case of severe accidents.

3.7 Emergency management at Swiss national level

On 4 July 2012, the Federal Council took note of the report by IDA NOMEX (the Interdepartmental Working Group to Review Emergency Preparedness Measures in case of Extreme Events in Switzerland) and instructed various Federal agencies to draft organisational and legislative measures. In this context, ENSI collaborated with representatives of the Federal Office for Public Health (FOPH), the Swiss Accident Insurance Fund (SUVA) and the Group of Swiss Nuclear Power Plant Operators (GSKL) in 2012 to compile a report on the prevailing situation regarding support and treatment for persons exposed to severe radiation and the agreements with the plants, and specific alternative solutions were proposed.

The current status of measurement and forecasting systems was assessed in collaboration with Federal agencies and the power plant operators. The requirements for these systems were redefined on the basis of this analysis and the lessons learned from Fukushima.

Completion of the review of reference scenarios and related assumptions for emergency preparedness was delayed due to the extensive documentation submitted by the licensees at the end of September 2012. This task is to be carried out as a project together with the review of the zoning concept in the areas surrounding nuclear power plants, in conjunction with the cantons and Federal agencies.

In November and December 2012, moreover, ENSI carried out inspections of the emergency control center (ECC) and substituted ECC at nuclear power plant sites. The inspection reports are being

drawn up. Human and organisational aspects of emergency management by nuclear power plant licensees are also addressed here. ENSI's emergency center in Brugg was inspected to determine its seismic resistance. Specific improvements have already been implemented and additional options for upgrading are under review. The option for an alternative location for ENSI's protected emergency center is also being followed up under the auspices of Business Continuity Management.

The measures for 2013 are set forth in sections 4.6 and 4.7.

3.8 Safety culture

The accident at Fukushima entails potential implications at multiple levels for the safety culture of Swiss nuclear power plants. On the one hand, the findings from the analysis of the accident should be considered to determine whether they can be applied to the safety culture of Swiss nuclear power plants. On the other hand, the political consequences of the accident in Switzerland, i.e. the decision to phase out from nuclear energy, should be considered to determine their potential impact on the safety culture. This self-examination and the implementation of any specific measures is the responsibility of the licensees of the Swiss nuclear power plants. In 2012, ENSI assured itself that the licensees are actually fulfilling this responsibility, during the "specialist discussions on safety culture", as they are known. These are open, constructive and discursive discussions on a chosen topic with the primary aim of encouraging the licensees to consider their own safety culture. Specialist discussions of this sort were conducted at all the nuclear power plants between July and December 2012. The topic proposed by ENSI was considered and discussed in the first session of each discussion. ENSI then made an evaluation of the discussions and reported the results to the licensees during a second discussion. The overall assessment of the specialist discussions and reports on them will be completed in the first quarter of 2013.

In addition to these specialist discussions, a specialist meeting was held at the Mühleberg nuclear power plant (KKM) on the subject of Personnel and Organisation. During this specialist meeting, ENSI obtained information about measures implemented by KKM or by BKW (the licensee) to deal with uncertainties regarding the timeframe for continued operation of the plant, and personnel policy in view of the decommissioning of the plant.

As the accident at Fukushima has shown, the safety culture of a licensee organisation is heavily influenced by the safety culture of the responsible supervisory authority (i.e. the supervisory culture), among other factors. By launching an internal project that will run for several years, ENSI has initiated a self-examination process to consider its supervisory culture. This project should help ENSI to learn the right lessons from the Fukushima accident for its own supervisory activities. New guiding principles for ENSI should also be drafted against this background.

3.9 Experience feedback

To examine the issue of experience feedback, topical inspections were carried out in all the nuclear power plants during the fourth quarter of 2012, focusing on the processes for the assessment of external occurrences. These inspections showed that suitable specified guidance documents are in place at the plants so that the external occurrences of relevance to each plant can be assessed in

greater detail. The interfaces to the relevant processes for the implementation of derived measures have also been defined throughout. As regards guidance documents for the analysis and derivation of measures, the relevant documents are in some cases available in the plants only in draft form. The plants have already recognized the need for improvement on this issue. The definitive documents, and the documents stipulating the reporting requirements to ENSI as per Guideline ENSI-B02, have yet to be submitted and will then be reviewed by ENSI. The review of documentation on experience feedback and any improvement measures that may be required are followed up in the Action Plan 2013.

3.10 International supervision and cooperation

Internationally harmonised assessment scales

The primary purpose of cooperation among international authorities to ensure the safety of nuclear technology is to continue the development and harmonisation of safety requirements so that those countries which utilise nuclear energy will have a set of regulatory instruments at their disposal. These include the Safety Standards of the International Atomic Energy Agency (IAEA) and the Safety Reference Levels of the Western European Nuclear Regulators' Association (WENRA). At the end of 2011, ENSI's Director was elected as Chairman of WENRA. ENSI is using this circumstance to make further progress with the development of harmonised Safety Reference Levels for all areas of nuclear energy, and to advance their implementation in European countries that use nuclear energy.

ENSI's formal order dated 1 June 2011 required the licensees of Swiss nuclear power plants to take part in the EU stress tests. These were carried out in Switzerland in the same way as in the EU countries with nuclear power plants. ENSI also took part in the peer review process which was completed by April 2012, whereby international teams assessed the country reports in overall terms and on a topic-by-topic basis according to standard criteria. At the technical level, WENRA set itself the goal of adopting the key findings from the EU stress tests immediately after publication of the main peer review report. The Safety Reference Levels are being examined to determine potential for improvements in this context. The results from the EU stress tests should also be incorporated into follow-up activities. For this purpose, the European Nuclear Safety Regulators' Group (ENSREG, the association of supervisory authorities in the EU member states) has adopted an action plan for follow-up measures.

Switzerland takes part in the IAEA's Safety Standards Groups on an ongoing basis. Switzerland also participated in the IAEA General Conference in September 2012 and the Ministerial Conference on Nuclear Safety at Fukushima in December 2012. As elements of the IAEA action plan, these events aim to help strengthen the international nuclear safety regime.

International reviews and transparency for supervision and licensees

A two-week IRRS mission with a team of 24 experts from 14 countries visited Switzerland in November 2011. The International Atomic Energy Agency (IAEA) completed the final report by the review mission, under the auspices of the Integrated Regulatory Review Service (IRRS), in May 2012. It contains 19 "Good Practices", 12 recommendations and 18 suggestions. By the end of 2012, ENSI drafted an action plan for the suggested improvements in view of the IRRS follow-up mission which is likely to take place in 2015.

An OSART (Operational Safety Review Team) mission visited the Mühleberg nuclear power plant (KKM) in October 2012. A team of experts from the International Atomic Energy Agency (IAEA) inspected operational safety for a period of more than two weeks. The OSART team drew up 21 recommendations and proposals regarding further improvements to operational safety at KKM. Ten Good Practices were also identified. ENSI observed the mission but did not participate in it directly. The IAEA published the final report in January 2013. An OSART follow-up mission to assess the measures implemented by KKM is likely to take place in 2014.

Convention on Nuclear Safety

An extraordinary conference on the Convention on Nuclear Safety (CNS) took place in August 2012. Switzerland submitted its country report for this event in May 2012, in compliance with the specified deadline; this was published on ENSI's website (see http://www.ensi.ch/de/2012/05/11/swiss-national report-to-the-second-cns-extraordinary-meeting/). In advance of the extraordinary conference, eleven countries (including Switzerland) submitted suggested changes to the CNS Guidance Documents, and they went on to develop joint proposals for changes at two Consultancy Meetings in June and July 2012. The Conference accepted at least the basic content of most of the proposals, including the changes desired by Switzerland. These changes bring about practical improvements to the content of the reports and their discussion during the conferences, but do not make any substantial or binding changes to the international safety regime.

Russia and Switzerland also submitted proposals to amend the Convention itself. In particular, Switzerland wanted to introduce binding status for the international peer reviews, the implementation of periodical safety reviews and improvements to transparency. Unfortunately, the proposals submitted to the Convention were unable to attract a consensus in this form. Instead, the parties to the Convention agreed to set up a working group (the "Effectiveness and Transparency Working Group"). By the next regular Review Meeting in 2014, this group will endeavour to draft broad-based proposals to improve the CNS and its processes.

3.11 Reitnau external storage facility

The central storage facility for Severe Accident Management equipment at Reitnau (canton of Aargau), which was the subject of a request by ENSI to all licensees of Swiss nuclear power plants in March 2011, was commissioned on 1 June 2011. On 20 January 2012, the operating company for the storage facility submitted the concept for the external storage facility for the Swiss nuclear power plants (ExLaReitnau) to ENSI, within the specified period. After assessing the submitted documentation and on the basis of an ENSI inspection report dated 31 May 2011, ENSI was able to determine from its initial assessment 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 nuclear power plants in case of severe accidents. ENSI's only criticism was levelled at the wired communication via a cable route which is buried but not redundant, because this connection is assessed as too unsafe on the assumption that the mobile telephone network would no longer be available due to overload or outage.

On 27 September 2012, ENSI carried out an inspection of inventory management at the Reitnau external storage facility with satisfactory results because the Accident Management equipment

indicated on the inventory list was fully present, in maintained condition and ready for deployment. The three underground buildings of the storage facility were in a clean, dry and tidy condition, and both the loading ramps and transport areas were ready to handle outbound transport by truck or helicopter at any time of the day or night.

Although there was no doubt that the buildings, erected for military purposes, are resilient to earthquakes, confirmation from a civil engineer expert was obtained at ENSI's request in January 2013; this states that the building complies with the seismic requirements for structures in class BWK III as per SIA standard 261.

The gradual deployment of Accident Management resources mentioned in the concept dated 20 January 2012 largely corresponds to ENSI's notion. Subsequently, however, it will be necessary to inspect the numerous interfaces for the deployment of the stored equipment and auxiliary supplies from the Reitnau external storage facility; these are currently being incorporated into the emergency procedures for the nuclear power plants on a gradual basis. These procedures will be assessed and their practicability will be verified by means of emergency exercises during the coming years (see 4.6). On the basis of these exercises, and in response to additions and changes in the Swiss nuclear power plants, necessary adaptations to the concept and the inventory will be implemented.

The assessment of the Reitnau external storage facility to date was summarised by ENSI in a report published in the first quarter of 2013.

An emergency exercise involving the deployment of the Reitnau external storage facility emergency team planned for November 2012 had to be postponed until 2013 because of unplanned repair works, which prolonged the refuelling outage 2012 at KKL (see 4.6).

4 Key issues in 2013

Based on their importance in relation to safety, and on synergies with ongoing projects, the following key issues were specified for ENSI's follow-up activities in view of Fukushima during 2013:

1. Earthquakes
2. Containment integrity
3. Extreme weather conditions
4. Increase in safety margins
5. Hydrogen management
6. Severe Accident Management
7. Emergency management at national Swiss level
8. EU stress tests follow-up
9. Experience feedback

4.1 Earthquakes

In compliance with formal orders from ENSI regarding protection against the 10,000-year earthquake, the Swiss nuclear power plants submitted new safety cases for the safe shutdown earthquake (SSE) in 2012. For this purpose, use was made of the seismic hazard assumptions (PRP Intermediate Hazard) current at the time in question based on the new earthquake catalogue issued by the Swiss Seismological Service (SED) and the site specific data acquired during the Pegasos Refinement Project (PRP). The calculation was based on current results from attenuation modelling.

Completion of the PRP project is planned in the second quarter of 2013. ENSI will then review the results and define new hazard assumptions. By the fourth quarter of 2013, the methodology and the timeline for the seismic safety case to be provided by the Swiss nuclear power plants will be redefined in detail. Following this, the safety case submitted by the licensees of nuclear power plants must be revised or a new one must be furnished. These activities conform to the "Hazard Assumption Ordinance" (SR 732.112.2, article 13), which states that in case of new hazard assumptions or of changes to the hazard assumptions on which the construction license is based, the licensee must carry out new deterministic and probabilistic safety analysis with the new assumptions, and must assess their impact on the safety of the plant and on the risk in particular.

In the course of analyses for the EU stress tests, ENSI became aware of a circumstance that proved advantageous during the severe earthquakes which occurred in Japan: in the Japanese nuclear power plants, automatic scrams were triggered upstream by means of the seismic instrumentation. Triggering of this sort has not yet been implemented in the Swiss nuclear power plants. In 2013, ENSI will set up a working group to examine whether automatic scrams should take place upstream, by means of the seismic instrumentation, in Swiss nuclear power plants.

Milestones for licensees:

2nd quarter of 2013: Completion of the Pegasos Refinement Project (PRP)

Milestones for ENSI:

4th quarter of 2013: Stipulation of the methodology and timeline for new seismic safety case

Concept regarding the advantages and drawbacks of upstream automatic scrams by means of seismic instrumentation

4.2 Containment integrity

a) Seismic robustness of the containment venting systems at Gösgen and Leibstadt nuclear power plants

Following the cursory review completed at the end of 2012, the detailed review of the submitted documentation by ENSI will continue into the second quarter of 2013. The first step will be to assess the actual state of the systems on the basis of updated documents. ENSI will then review the improvement measures proposed by the licensees.

b) Seismic robustness of the isolation for the containment and the primary circuit

The cursory review was completed for the plants in question at the start of 2013 (for KKB, the review was already completed within the seismic safety case supplied in 2012, see section 3.1). The cursory review produced certain further requests regarding the submission of additional documents. These documents will be submitted in the first quarter of 2013 and will be taken into account by ENSI in its statement to be issued in the second quarter of 2013.

c) Requirements for containment integrity

The main report of the peer review team in connection with the EU stress tests (April 2012) includes a recommendation at European level that the containment, as the final barrier before the release of radioactive substances, plays a key role in severe accidents. Switzerland's nuclear power plants already have equipment and measures in place which largely guarantee attainment of the "Confinement of radioactive substances" fundamental safety function; their rating in the review by international experts was therefore good. ENSI is actively involved in the technical working group of WENRA (a sub-group of the Reactor Harmonization Working Group), which is currently focusing on containment integrity in case of severe accidents. In particular, the group will review the existing WENRA requirements and will adapt them where necessary. ENSI will then examine whether the requirements for the revised Safety Reference Levels are met in Switzerland.

Milestones for licensees:

1st quarter of 2013: Submit documentation from cursory review

Milestones for ENSI:

2nd quarter of 2013: Statement by ENSI on seismic robustness of the isolation of the containment and the primary circuit

Statement by ENSI regarding the seismic robustness of the containment venting systems at KKG and KKL

End of 2013: Review of Safety Reference Levels for containment integrity

4.3 Extreme weather conditions

ENSI defined the requirements for the probabilistic hazard analyses and safety case needed to demonstrate adequate protection of plants against extreme weather conditions in greater detail during 2012.

At the end of 2012, in compliance with an ENSI request to this effect, the plants submitted a concept for proving adequate protection; this is currently under review. The probabilistic hazard analyses and safety case for extreme weather conditions, including statements of safety margins, must be submitted to ENSI by the end of 2013.

Milestones for licensees:

End of 2013: Safety case for extreme weather conditions

Milestones for ENSI:

1st quarter of 2013: Statement by ENSI regarding the concept

4.4 Increase in safety margins

Following the events at Fukushima, investigations were conducted and demonstrations were provided during 2011 and 2012 in connection with external natural events and sequences entailing the failure of essential safety systems which create increased autonomy requirements for the nuclear power plants; these activities confirmed that the Swiss nuclear power plants display a high level of protection against the impact of the accidents that were analysed. The requirements for safety provisions stipulated by law to comply with the fundamental safety functions (control of reactivity, cooling of fuel elements and confinement of radioactive substances) are met. Moreover, the safety margins are available. These are mainly attributable to the robust design of the special emergency systems at the plants, which are specially protected against external events.

In the Swiss country report on the EU stress tests (December 2011), the concept of "safe shutdown paths" was used to supply deterministic proof for the first time; safe shutdown paths enable the plants to be brought into a safe shutdown state after accidents. Swiss nuclear power plants have three safe shutdown paths. The first path comprises the conventional safety systems. The special emergency systems constitute the second safe shutdown path, which is designed primarily to cope with extreme external events and sabotage acts. The preventive accident management measures implemented in all the nuclear power plants form the third safe shutdown path. These comprise manual measures to be carried out locally by the operating staff; they are defined in specific emergency procedures and are carried out with the use of permanently installed or mobile equipment. This approach (deterministic demonstration by means of safe shutdown paths) allows an assessment of the robustness of the individual safe shutdown paths and therefore provides an additional analytical tool to increase safety margins.

As a consequence of the accident at Fukushima, ENSI ordered specific backfitting measures to cope (in particular) with severe accidents at the Swiss nuclear power plants; some of these measures have already been implemented, while others are still in the planning phase. In addition, the Swiss nuclear power plants have implemented further improvements such as the procurement of additional mobile power supply units for the specific purpose of improving autonomy in case of severe accidents.

Increasing safety margins in case of accidents beyond the design basis is a key issue for analysis work in 2013. Based on the results of probabilistic and deterministic analyses, the objective is to identify areas where backfits could contribute the most towards a further reduction of the hazard, taking account of the principle of adequacy. The licensees of the Swiss nuclear power plants will draft potential solutions to increase the safety margins in these areas. There will be a special focus on strengthening the third safe shutdown path. A systematic overview will be used to show that, as a result of the measures developed, all appropriate precautions have been implemented to bring about a further reduction of the hazard by means of permanently installed systems or prepared measures that are available at short notice.

This year, as the third safe shutdown path is strengthened, ENSI will also review extended requirements (e.g. design requirements or testing intervals) for accident management equipment under conditions resulting from extreme external events. These include, for example, the emergency power supply for the instruments required for severe accident management.

<u>Milestones for licensees:</u>

End of 2013: Analyses for increasing safety margins

<u>Milestones for ENSI:</u>

2nd quarter of 2013: Drafting of requirements and boundary conditions for the analyses on increasing safety margins

4th quarter of 2013: Requirements for accident management equipment are defined

4.5 Hydrogen management

a) *Containment venting*

ENSI's review of the studies submitted by KKG and KKB in 2012 (regarding the improvement of displays in the emergency control room and the updated post-LOCA study) is scheduled for 2013.

b) Hydrogen management

As already noted in connection with the EU stress tests, various aspects of the hydrogen hazard in case of severe accidents in the reactor should be reconsidered. Extensive studies have already been carried out in connection with the probabilistic safety analysis, so important basic material is already available. Based on the review in connection with the EU stress tests and the NSC's report, the following analyses are to be carried out by the Swiss nuclear power plants:

- Review of robustness and scope of measuring equipment in connection with the assessment of the hydrogen hazard
- Updating of analyses regarding the hydrogen hazard and investigation of the propagation of hydrogen from the containment into other nuclear power plant buildings
- Review of the measures and procedures in place for protection against the hydrogen hazard
- Review of the containment venting path in respect of the hydrogen hazard.

Milestones for licensees:

End of 2013: Submission of studies regarding the hydrogen hazard in case of severe reactor accidents

Milestones for ENSI:

1st quarter of 2013: Specification of requirements for the review of the hydrogen hazard in case of severe accidents

4.6 Severe Accident Management (SAM)

Severe Accident Management (SAM) includes the implementation of measures following core damage accidents to cool the damaged reactor core and to limit or reduce the release of radioactive substances into the surrounding area. As the reactor accident at Fukushima shows, these activities have to be carried out for prolonged periods under unfavourable radiological conditions, thereby creating the requirement to provide an infrastructure that remains operable in the long-term under accident conditions.

In connection with infrastructure, in 2012 ENSI requested the plants to submit a report on the long-term operability of the emergency control center (ECC) and substituted ECC to ENSI by the end of the first quarter of 2013. The plants submitted these reports by the specified deadline and they are currently under review. On the basis of these reports, ENSI will carry out follow-up inspections of the emergency accommodations for prolonged deployments this year, and will order additional measures as required.

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 will also be tested during the course of this year. These tests will be carried out as part of an unannounced alarm exercise and an emergency exercise in one plant.

Milestones for licensees:

1st quarter of 2013: Submission of reports on long-term operability after core damage accidents with large releases (all plants)

4th quarter of 2013: Operational readiness of the external storage facility is tested and SAM equipment is transported to a plant as part of an emergency exercise

Milestones for ENSI:

4th quarter of 2013: Completion of inspections of the emergency accommodations for prolonged deployment after core damage accidents with massive releases

Procedures for the deployment of the equipment from the external storage facility are tested

4.7 Emergency management at Swiss national level

a) IDA-NOMEX

ENSI coordinates its activities with other Federal agencies and cantons on the basis of the measures adopted by the Federal Council and included in the final report of IDA NOMEX (the Interdepartmental Working Group to Review Emergency Preparedness Measures in case of Extreme Events in Switzerland) issued in July 2012. ENSI will also devote attention to the implementation of international recommendations and the problem of liquid radioactive discharges as a consequence of reactor accidents. ENSI's work for 2013 is as follows:

The reviews of existing reference scenarios for emergency preparedness will be completed, in collaboration with representatives of the cantons, Federal agencies and nuclear power plants. The results will be incorporated into the review of emergency preparedness zones which will then be carried out by the same working group.

In case of accidents at nuclear power plants, deployments of external emergency preparedness organisations and notifications to neighbouring countries are linked to specified levels on the International Nuclear Event Scale (INES). The IRRS issued a recommendation to Switzerland that the classification of emergencies and the ensuing deployment of emergency preparedness organisations should be geared to a special IAEA classification system created for emergencies; ENSI will therefore carry out a study regarding the implementation of the IAEA emergency classification system in the nuclear power plants and at ENSI itself in 2013.

The importance of redundant and fail-safe communication equipment in order to terminate an emergency was addressed in the final report by IDA NOMEX. One of the measures taken in this regard was to task the Federal Office of Civil Protection (FOCP) / Department of Defence, Civil Protection and Sport (DDPS) with the definition of requirements for redundancy and fail-safe operation of communication equipment. For its part, ENSI is examining various options such as satellite-based communication in order to be able to compensate for the decrease in redundancy originated by the loss of the AF network in 2011. This year, ENSI will introduce the "safety radio network" offered by Polycom (Switzerland) AG as an alternative communication system.

Even in the case of an accident at a nuclear power plant triggered by an external extreme event (e.g. a severe earthquake), the availability of measurement and forecasting systems must be ensured. For this purpose, for example, it is necessary to examine the acceleration sensitivity of the measurement electronics. In the course of 2013, ENSI will inspect the dose rate measurement sensors currently in operation to determine whether they are able to function in case of the accelerations which can occur during severe earthquakes. By the end of 2013, ENSI will also determine whether Guideline B-12 adequately defines the requirements related to seismic resistance of accident instrumentation (including the emergency power supply) for the implementation of AM measures in particular, and for the plant parameters transmitted to ENSI.

b) Dispersion of contaminants in watercourses

As a result of the Fukushima accident, significant quantities of radioactively contaminated water were discharged into the sea in addition to the airborne releases of radioactive substances. ENSI will require 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.

In 2012, ENSI drafted a report on the situation in Switzerland in case of a discharge of large quantities of radioactivity into the rivers Aare and Rhine; the Federal agencies and cantons concerned are carrying out the consultation process regarding this report until the end of February 2013. The need for action to optimise protective measures for the population in such cases will be determined after completion of the consultation process in 2013, in liaison with the cantons and Federal agencies.

Milestones for licensees:

4th quarter of 2013:	Studies on plant-specific application of the IAEA emergency classification system are completed (for all plants)
	Studies of scenarios, release paths and possibilities for minimising waterborne radioactive discharges are completed

Milestones for ENSI:

2nd quarter of 2013:	Report on the review of the reference scenarios
4th quarter of 2013:	Report on the review of the zoning concept
	The POLYCOM communication system has been fully introduced at ENSI

4th quarter of 2013: The need for action to optimise measures to protect the population in case of waterborne radioactive discharges is determined

The functional capability of dose rate measurement sensors in case of earthquakes has been reviewed

Guideline B12 has been reviewed to determine necessary adaptations

4.8 Experience feedback

The plants must finalise those guidance documents for the analysis of external occurrences and for the derivation of measures which were only available in draft form when ENSI carried out its topical inspections in 2012. The requirements for reporting to ENSI as per Guideline ENSI-B02 must be revised where a need for improvements was identified during the inspections. The aforementioned documents must be submitted to ENSI by the deadlines in the second half of 2013. ENSI will then assess the submitted documents.

Switzerland assesses operational experience from foreign nuclear power plants. On the one hand, statutory requirements oblige the licensees to evaluate events abroad for the purpose of gaining knowledge for their own plants. On the other hand, ENSI keeps track of the key issues at international level (in bilateral committees and international working groups of the NEA (Nuclear Energy Agency) and the IAEA). ENSI is also a member of the "European Clearinghouse on NPP Operational Experience Feedback", a body of experts which focuses on knowledge gained from operational experience on the basis of event analyses, assessments and reporting. ENSI plans to subject its own process for the assessment of foreign operating experience to a review in order to identify potential for improvement and, as an option, to initiate closer collaboration with the Clearinghouse.

Milestones for licensees:

4th quarter of 2013 Updated guidance documents are available (all plants)

Milestones for ENSI:

4th quarter of 2013 Review of the ENSI process for the assessment of foreign operating experience

4.9 EU stress tests follow-up

The European Nuclear Safety Regulators' Group (ENSREG) approved an action plan for follow-up measures to the EU stress tests in 2012. Its objective is to request the participating countries to draw up their own national action plans for the implementation of the measures resulting from the EU stress tests. Switzerland participates actively in this process. ENSI has drawn up a status report for the implemented and planned measures (as per end of 2012) and will continue to take part in the follow-up actions. ENSREG will review and compare the implementation measures by the participating countries during a workshop at the end of April 2013. ENSREG currently plans to issue an action plan every year.

Milestones for licensees:

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Milestones for ENSI:

2nd quarter of 2013	Peer review of the national action plans (ENSREG workshop)
4th quarter of 2013	2013 status report to ENSREG

5 Annexes

Legenda to column 3 (status/action plan)

2013 Key issue in the action plan for 2013
LA Issue incorporated into ongoing supervisory activities
NI Issue yet to be initiated
B Issue dependent on IDA NOMEX

5.1 Annex 1: List of checkpoints from "Lessons Learned"

No	Designation	Status / action plan	**Description**	Implementation text
1	PP1	2013	**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.**	Earthquakes: the first review of the seismic safety case based on intermediate hazard assumptions (PRP Intermediate Hazard) was completed in June 2012. Determination of the definitive hazard will be completed in the course of the PRP project in 2013, followed by new seismic analyses by the NPP licensees. External flooding: hazard assumptions were reviewed in 2011. Combination of earthquakes/earthquake-induced flooding was covered in 2012. Extreme weather conditions: the licensees will submit their safety case in 2013.
2	PP2	LA	**The coping strategies for a prolonged loss of electric power supply must be re-evaluated on the basis of knowledge gained from Fukushima.**	The strategies were reviewed during topical inspections in all NPPs at the end of 2012: the plants have effectively continued to develop their existing strategies, and adequate resources for AM are available in order to prevent core damage after an SBO. Work will be followed up as part of ongoing supervisory activities.

No	Designation	Status / action plan	**Description**	Implementation text
3	PP3	LA	**It should be checked 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.**	Screening analyses of coolant supply were completed in 2012; at all plants except Mühleberg, adequate redundancies are available in order to guarantee the coolant supply. KKM must backfit a diverse heat sink. The work will be followed up as part of the DIWANAS project.
4	PP4	LA	**It should be checked whether the requisite tightness of buildings containing important safety equipment is guaranteed in case of flooding of the site.**	The safety case for the 10,000-year flood was accepted by ENSI in 2011. Work still outstanding was incorporated by ENSI into individual follow-on tasks so that their processing will continue as part of the normal supervisory activities.
5	PP5	2013	**On the basis of experience gained from the Fukushima accident, it should be checked whether the availability of the instrumentation required to assess the condition of the plant is guaranteed adequately even in extreme situations.**	Backfitting of instrumentation to monitor the spent fuel pools was required in the formal order dated 05.05.2011. Backfitting projects for this purpose are in progress in all NPPs; permits for these have been issued by ENSI, which also supervises the implementation. In 2013, activities are planned with regard to accident instrumentation, as defined in ENSI-B12 (see section 4.6). In addition, ENSI will address extended requirements for SAM equipment (see section 4.4).
6	PP6	LA	**It should be checked whether control of leaks and long-term cooling of the spent fuel pools are guaranteed in case of severe accidents.**	Reviews took place in 2011 and 2012. Permits for backfitting projects at the Beznau and Mühleberg NPPs are being issued by ENSI, which also supervises the implementation.
7	PP7	2013	**It should be checked whether tests and inspections regarding the prevention of hydrogen explosions should be extended to additional areas of the plants beyond the primary containment.**	In 2013, ENSI requires a reconsideration of various aspects of the hydrogen hazard in case of severe accidents in the reactor (see section 4.5). Topics are: analyses of the hydrogen hazard including propagation of hydrogen from the containment into other buildings of the nuclear power plant, robustness and scope of measuring equipment, measures and procedures in place, review of the containment venting path.
8	PP8	2013	**The design and operation of the systems for filtered venting of the containment must be addressed again.**	The filtered venting system was examined both in the EU stress tests ("Measures and design to protect containment integrity") and in the course of topical inspections by ENSI which relate specifically to knowledge gained from the accident at Fukushima-Dai-ichi. Containment integrity continues to be a key issue in 2013.
9	PP9	B 2013	**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.**	ENSI has reviewed the specific requirements on the basis of the knowledge obtained though IDA NOMEX. Compliance with the requirements will be examined in 2013.

No	Designation	Status / action plan	**Description**	Implementation text
10	PP10	B 2013	**It should be checked whether the emergency control center (ECC) and the substitute ECC at the Swiss nuclear power plants still meet the requirements, based on the experience gained from the Fukushima accident.**	Requirements for technical emergency preparedness equipment at nuclear installations are stipulated in ENSI Guideline B12. On the basis of knowledge gained from investigations of the accident at Fukushima, from IDA NOMEX and from new inspections, ENSI will review the specific requirements for ECC and substitute ECC and check their implementation in practical terms.
11	PP11	LA	**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 security. Monitoring of radiation protection must continue to be guaranteed in this context.**	This issue was initially addressed in the course of existing supervisory activities taking into consideration the additional knowledge gained from the Fukushima accident. Follow-up will continue in the course of ongoing supervisory activities.
12	PP12	2013	**The emergency measures for heat removal 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.**	After the construction of the Reitnau external storage facility, resources were already made available for use in a situation of this sort in order to maintain the cooling function independently of the permanently installed safety systems. In addition, this issue is included in the scope of the EU stress tests ordered by ENSI on 01.06.2011. A comprehensive review of the deployment of resources from the Reitnau external storage facility will take place in 2013 in connection with an emergency exercise.
13	PP13	LA	**It should be checked how the alternative supply of water and power for emergencies is ensured.**	Operational resources have been held in readiness at a central point at the Reitnau storage facility since 2011; in addition, storage facilities have been set up at the NPP sites. Hook-up points at the NPPs have been backfitted as necessary. Their review will be part of the regular emergency exercises. In addition, this topic will be considered again as part of the "Increased margins" key issue (see section 4.4).
14	PP14	LA	**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.**	Available reserves of water have already been reviewed and are already documented in the existing emergency procedures. This topic will be considered again as part of the "Increased margins" key issue (see section 4.4).
15	PP15	B 2013	**Emergency management must be reviewed to determine further potential for improvement.**	Implementation will take place under the auspices of IDA NOMEX. The resultant specific requirements for nuclear installations will be supervised by ENSI.

No	Designation	Status / action plan	Description	Implementation text
16	PP16	LA	**ENSI has identified the following issues for improving emergency planning and emergency exercises:** **a The decision-making guidance 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 prolonged Station Blackout (SBO) 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 subcriticality in the long term in case of severe accidents.** **b Consideration given to accidents involving a prolonged SBO in the planning of emergency exercises.** **c Examination of whether the processes are trained often enough during emergency exercises. Particular attention should be given here to a functioning inter-organisation chain of communication across the various organisations.**	The Swiss NPPs have a comprehensive system of accident and emergency procedures, complemented by the SAMG. ENSI considers that a new assessment in the light of events at Fukushima would serve the interests of safety. In the course of ongoing supervisory activities, there will be re-assessments of the regulatory requirements (ENSI-B12) and the implementation of SAMG in the plants. In connection with the implementation of ENSI's formal order dated 18.03.2011, an external emergency storage facility (Reitnau) for all NPPs in Switzerland was already established on 01.06.2011. Among other items, stocks of boron compounds are kept in readiness here to ensure the long-term maintenance of subcriticality.
17	PP17	B 2013	**It should be checked whether and to what extent the communication facilities are designed with adequate redundancy and diversity.**	Implementation will take place under the auspices of IDA NOMEX. The resultant specific requirements for nuclear installations will be supervised by ENSI.
18	PP18	B 2013	**It must be ensured that adequate staff is available at all times to accomplish all necessary emergency management activities.**	Implementation will take place under the auspices of IDA NOMEX. The resultant specific requirements for nuclear installations will be supervised by ENSI.
19	PP19	LA	**Measures that increase the organisation's ability to react to unexpected events must be reviewed again on the basis of experience gained from Fukushima.**	Actions related to this issue are followed up by the Human and Organisational Factors section in the course of ongoing supervisory activities.
20	PP20	B 2013	**Transmission of plant parameter data must be re-evaluated with respect to an alternative, independent means of data transmission.**	The specific requirements are being drawn up by ENSI on the basis of knowledge acquired through IDA NOMEX. ENSI will introduce the " safety radio network" of POLYCOM Switzerland AG as an alternative communication system.

No	Designation	Status / action plan	**Description**	Implementation text
21	PP21	B 2013	**The evacuation concepts must be reviewed, taking account of knowledge gained from the Fukushima accident.**	Implementation will take place under the auspices of IDA NOMEX.
22	PP22	B 2013	**Coordination with other international partners is required to determine whether and how an international network for central international emergency support can be set up.**	Implementation will take place under the auspices of IDA NOMEX. The resultant specific requirements for nuclear installations will be supervised by ENSI.
23	PP23	B 2013	**It should be checked whether the necessary information regarding forecasts of releases and radiation exposure is provided in a timely and continuous manner in case of accident.**	The specific requirements are being drawn up by ENSI on the basis of knowledge acquired through IDA NOMEX.
24	PP24	B 2013	**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 It should be checked 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 It should be checked whether the timely communication of radiological effects, including calculated forecasts, is also ensured beyond Switzerland's borders.**	Implementation will take place under the auspices of IDA NOMEX. The resultant specific requirements for nuclear installations will be supervised by ENSI.
25	PP25	NI	**It is necessary to examine the extent to which the release of non-nuclear hazardous substances in case of beyond design basis accidents could exert an additional influence on the accident sequence, and which counter-measures are required.**	-
26	PP26	2013	**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.**	ENSI has continued to optimise the relevant internal structures. Activities related to operating experience feedback from international occurrences are planned in 2013.

No	Designation	Status / action plan	**Description**	Implementation text
27	PP27	2013	**It must be guaranteed that the knowledge gained from national and international operating experience (event analysis) in the licensees' organisations reaches all the relevant individuals and units (including those at group level).**	Inspections of this aspect were carried out by ENSI at all NPPs in the fourth quarter of 2012. Follow-up measures will receive further attention from ENSI as a key issue activity in 2013.
28	PP28	LA	**It must be ensured that internationally harmonised assessment criteria for nuclear safety are established at the highest level of safety.**	Switzerland collaborates continuously in the Safety Standards Groups (SSC) and other important IAEA bodies. Under the auspices of WENRA, ENSI advocates the development of harmonised Safety Reference Levels (SRL) and their implementation in European countries that use nuclear energy. Six new working groups within the RHWG (Reactor Harmonisation Working Group) are to draft proposals in 2013 for the integration of new knowledge from the EU stress test into the SRLs.
29	PP29	LA	**Greater importance should be accorded also at international level to the recommendations resulting from international reviews (IRRS, OSART) and from the regular Periodic Safety Reviews (PSR). The transparency of ENSI's supervision and of the operators' safety-related activities must be increased.**	An OSART (Operational Safety Review Team) mission was carried out at KKM in October 2012. On the basis of the recommendations and suggestions ENSI got during the 2011 IRRS mission, ENSI has (by the end of 2012) developed an action plan for the follow-up mission which will probably take place in 2015. In May 2012, by the specified deadline, Switzerland submitted its country report for the extraordinary conference on the Convention on Nuclear Safety (CNS). At the conference in August 2012, Switzerland advocated further improvements to the international safety regime. A working group is to draft proposals to improve the CNS and its processes by the time of the next regular conference in March/April 2014. Switzerland is participating actively in this work.
30	PP30	LA	**ENSI is reviewing the significance of the lessons learned from the Fukushima accident for its supervisory activities.**	ENSI worked to adopt an analytical approach regarding its own supervisory strategy well before the accident in Japan. In this context, ENSI is currently carrying out an internal project on the topic of supervisory culture. The review of the regulatory framework will continue in the course of ongoing supervisory activities. Specific issues are covered by other checkpoints.
31	PP31	LA	**Additional operational resources must be kept in readiness for radiation protection in case of severe accidents.**	Establishment of the Reitnau external storage facility in 2011. Reviews of the adequacy of the resources to be kept in readiness are carried out at regular intervals.
32	PP32	B 2013	**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 or loss of normal emergency power.**	The specific requirements for checking adequate implementation in relation to this issue are being drawn up by ENSI on the basis of knowledge acquired through IDA NOMEX. Accident instrumentation will be reviewed again in 2013 (see section 4.7).

No	Designation	Status / action plan	**Description**	Implementation text
33	PP33	B 2013	**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.**	The specific requirements for checking adequate implementation in relation to this issue are being drawn up by ENSI on the basis of knowledge acquired through IDA NOMEX.
34	PP34	B 2013	**It is necessary to stipulate arrangements for dealing with contamination in the area surrounding nuclear installations following severe accidents.**	On the basis of knowledge from IDA NOMEX, it is planned to define the specific requirements for checking adequate implementation in relation to this issue in connection with the revision of the Radiological Protection Ordinance.
35	PP35	2013	**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.**	In 2013, the NPPs will present the envisaged scenarios, including the requisite technical equipment, to retain large quantities of contaminated water.
36	PP36	2013	**As part of the emergency planning for severe accidents, it must be ensured that sufficient radiation protection staff is available on site.**	In 2013, inspections will be carried out and supervisory discussions will be conducted with the NPP licensees on this aspect.
37	PP37	LA	**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.**	Knowledge from the accident at Fukushima was integrated into the activities related to safety culture in the NPPs and at ENSI during 2012, and this will be continued in subsequent years as part of the regular activities related to safety culture.

5.2 Annex 2: List of open points from the EU stress tests

No	Designation	Status / action plan	**Description**	Implementation text
38	OP2-1	2013	**ENSI will follow up on the question as to whether in the Swiss nuclear power plants automatic scrams should be triggered by the seismic instrumentation.**	An upstream automatic scram by means of seismic instrumentation has not yet been implemented in Swiss nuclear power plants. A working group at ENSI will draft a concept in 2013 regarding the advantages and drawbacks of an upstream automatic scram by means of seismic instrumentation.
39	OP2-2	2013	**In respect of seismic proof that has still to be supplied, ENSI will follow up on a more detailed examination of the seismic robustness of the isolation of the containment and the primary circuit.**	Proof was submitted by the licensees in 2012 and the cursory review by ENSI was completed. Further processing will take place in 2013.
40	OP2-3	2013	**ENSI will follow up on measures to improve the seismic stability of the containment venting systems in case of beyond-design basis accidents for KKG and KKL.**	Proof was submitted by the licensees in 2012 and the cursory review by ENSI was completed. Further processing will take place in 2013.
41	OP3-1	LA	**ENSI will follow up on the impacts of a total debris blockage of hydraulic engineering installations.**	Proof was submitted by the licensees (KKB, KKG and KKM) in 2012. For KKB and KKM, ENSI determines that no cliff-edge effects from debris blockage are to be expected. Further processing will take place in 2013.
42	OP4-1	2013	**ENSI will follow up on the proofs of protection against extreme weather conditions, including combinations thereof.**	Requirements were defined by ENSI in 2012. Proof of adequate protection against extreme weather conditions is to be furnished by the licensees in 2013.
43	OP5-1	LA	**ENSI will follow up on the development of a compre-hensive strategy for the targeted deployment of the mobile accident management emergency diesels in order to secure selected direct current and/or alternating current consumers in the long term under total SBO (resp. SBO) conditions.**	Inspections of this aspect were carried out by ENSI in the fourth quarter of 2012. The results will be assessed in the first quarter of 2013. Any follow-up measures will be implemented by ENSI in the course of its ongoing supervisory activities.
44	OP6-1	2013	**From the point of view of risk minimisation, ENSI will follow up on the extent to which the current deployment strategies for the venting systems in severe accidents should be retained.**	Containment integrity is a key issue in 2013.
45	OP6-2	NI	**ENSI will follow up on whether restoring containment integrity during shutdown in the case of a total SBO represents a time-critical measure.**	-

No	Designation	Status / action plan	**Description**	Implementation text
46	PRT-1	2013	**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.**	ENSI specified detailed requirements for the probabilistic hazard analyses and the proof of adequate protection of plants against extreme weather conditions in 2012. In 2013, the licensees will submit proof (including statements on the available safety margins) to ENSI.
47	PRT-2	2013	**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.**	In 2013, ENSI requires a reconsideration of various aspects of the hydrogen hazard in case of severe accidents in the reactor. The topics are: analyses of the hydrogen hazard including the propagation of hydrogen from the containment into other buildings of the nuclear power plant, robustness and scope of the measuring equipment, measures and procedures in place, and review of the containment venting path.

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