

## **Post-Fukushima NAcP - STATUS REPORT**

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### Introduction

Following the European stress tests requested by the European Council as consequence of the Fukushima Dai-ichi nuclear power plant accident on 11 March 2011, each participating country prepared its National Action Plan (NAcP). In addition to the European Union Member States, Switzerland and Ukraine participated in this activity.

Based on the importance of the European Stress Tests and the two workshops held in April 2013 and 2015 that reviewed progress on the National Action Plans, the requirement to update the action plans was agreed by the European Nuclear Safety Regulators Group (ENSREG) and was subsequently included in the ENSREG work programme. Participating Member States committed to update their National Action Plans in 2017 and for updates to be published periodically, every 2 years, starting from 2017, until completion of their respective NAcPs.

This summary report is based on the last update submitted by each country and has been prepared by WG1 to provide the latest status on implementation of the NAcPs. As part of the process of continuous improvement many regulators have updated, or are updating, their regulatory requirements taking into account the lessons learned from the Fukushima Dai-ichi accident and the updated WENRA Safety Reference Levels. The implementation of any new requirements that they may define is likely to require additional measures to improve safety, with an appropriate schedule for implementation.

In general, countries have shown that most of their actions have been implemented or are on schedule. Most significant safety improvements include e.g.:

- Installing means for managing severe accidents (including containment pressure control and hydrogen management),
- Installing additional means for heat removal functions,
- Installing additional means for ensuring emergency power.

On the other hand, compared to the original plans, several delays have been reported. The original action plans were made based on the best available information about the measures needed and the estimated time schedules to implement them. When more detailed schedules were planned and implementation measures were carried out, some changes became necessary or unavoidable. These delays are a result of different causes, including ones that are outside the influence of the licensee or the regulator. Dealing with such delays requires regular engagement and interaction between regulators and licensees. The national regulators determine the acceptability of delays versus the overall plan of safety improvement activities that are ongoing based on several sources, e.g. from Periodic Safety Reviews. There are also many other modernisation projects ongoing at the operating NPPs

(e.g. I&C renewal) which also include measures for safety improvements. An optimization of risk is applied and quality of the measures is considered more important than rapid implementation alone. Some reasons for a delay might be:

- The measure cannot be applied, new solution to be found
- New difficulties are identified during the implementation which delay the finalisation of the measure
- Difficulty in identifying a competent supplier or the supplier cannot deliver in a timely manner
- Delays during the regulatory assessment - the regulator has requested additional information / analysis
- In case of a complex project the implementation is influenced by administrative procedures
- Other plant modifications improving overall safety of the plant and using for example the same design resources are prioritised
- Implementation only possible during refuelling /reactor outage
  - Small delays in preparation leads to delay to next reactor outage
  - Event with major impact may lead to rescheduling of the reactor outages
- The time demands and rules of public procurement procedures.

The details of still ongoing measures, their schedules and any possible reasons for delays compared to the original plan are described by each country. In addition, those countries who have already finalised their NAcP describe the most significant measures implemented.

## **Belgium**

The final Belgian national report was published in September 2020.

The licensee, ENGIE-Electrabel, had finalized the stress-tests action plan by mid-2020.

Since 2011, the sites of Doel and Tihange have witnessed several major achievements: reinforcement of structures, systems and components to face severe earthquakes, construction of protections against flooding, additional mobile means, such as mobile pumps and mobile diesels. Both sites are now adequately protected against natural hazards, such as flooding and earthquakes.

By the end of 2017, the strategy for the Complete Station Black-Out (CSBO) and for the Loss of Ultimate Heat Sink (LUHS) is well-defined on both sites and the related works were finalized.

The construction of filtered venting systems on all reactor buildings at Doel and Tihange was finalized in 2017 for most units, and in 2019 for the two remaining units (Doel 1 & 2) in the framework of their LTO action plan.

The sites are now protected against external hazards and prepared against CSBO and LUHS events.

The last actions are now complete. The new emergency response facility (backup to current site operation centre) in Tihange is now built and the licensee has completed final acceptance of the building.

A complementary assessment, issued from the review of closed actions, concerning the revaluation of the capacity of the sewage system in Tihange in case of heavy rains has been finalized and reviewed in 2020.

Some documentary work will then remain for the Regulatory body in order to validate the final acceptance of the last improvements.

## **Bulgaria**

The status of the activities has been updated and represents the situation as of March 20120. The updated National Action Plan (UNAcP) comprises a total of 78 measures and activities.

A considerable number of the measures listed are completed. The implementation status of the UNAcP measures is as follows:

- Completed – 73 measures (94%);
- Under implementation – 5 measures (6%).

The remaining 5 measures are in advanced stage of implementation but there is currently a delay and a term change is proposed by the operator. All of these ongoing activities should be finalised by 2021. Their status is as follows:

1. Construction of Kozloduy NPP off-site Emergency Response Centre (ERC), new term extends to December 2021:

This measure is in progress and according to the new term it is estimated to be completed by the end of 2021. The target term has been changed several times due to legal and administrative issues arising from procurement procedures as well as the need of coordinating the project with a large number of external organizations for the purposes of assignment and implementation of the detailed design.

2. Installation of measuring channels to monitor and evaluate the concentration of steam and oxygen in the containment, new term extends to December 2021:

The implementation of the measure requires design and engineering of unique hardware and software that comply with the design features of the VVER-1000 plants and the expected parameters in case of a severe accident, also the implementation of part of the planned changes could be implemented only during the annual outages.

3. Installation of an additional pipeline to the spent fuel pool cooling system for backup cooling from an external source, new term to December 2021:

The activities on installing an additional pipeline to the spent fuel pool (SFP) cooling system in order to ensure cooling redundancy of the fuel assemblies and direct water injection from an external source were completed on both units in 2015. In accordance with the Project for Long-Term Operation of the Units 5 and 6 and based on the analyses and assessments of the SSCs carried out in 2016, a replacement of the pneumatic valves for isolation of the SFP cooling system pipelines was performed. The design of a new pneumatic valve control system in case of beyond design accidents of the reactor of units 5 and 6 is completed. The implementation of the construction works is scheduled during the annual outages in 2020 and 2021.

4. Feasibility study of direct water injection to the reactor core from an external source, new term extends to December 2020:

A technical specification has been prepared for the assignment of the activity, but the measure sets tasks that exceed the current design basis and therefore the development of a conceptual and detail design for direct water injection to the reactor core from an external source is related to a number of exploratory, analytical and design activities. Due to these considerations the implementation term was extended until the end of 2020.

5. Feasibility study of direct water supply to steam generators from an external source, new term extends to December 2020:

Currently the conceptual and detailed designs were developed. The main reasons for the extension are administrative and relate to the rules for conducting public procurement procedures.

## **Czechia**

According to the updated report available to ENSREG (from December 2019), all measures contained in the Czech Action Plan have already been completed by the end of 2018. The only exception is Action 50 aimed at implementation of measures for maintaining long-term containment integrity in the Temelín NPP, which is scheduled to be completed by the end of 2024. The Action 50 date of completion has been originally set to the end of 2022 on the basis of the analyses carried out within another Action (49), completed in 2014. However, since that time the license holder ČEZ, a.s. has found out that the measures initially envisaged as Action 50 resolution are not reasonably implementable and has decided to supplement further solutions, namely to implement an additional independent system, which can terminate the severe accident progression in its early phase and prevent reactor pressure vessel failure and provide alternative long-term containment heat removal using added mobile pumping station driven by diesel engine, and also to implement the containment filtered venting system, which can prevent the containment overpressure failure. Besides, there are some Actions in the Czech Action Plan, such as regular assessment of state-of-the-art severe accidents measures and procedures, safety culture, emergency plans, etc., communication with stakeholders, and international cooperation, which are of a continuous and on-going nature and therefore have no final date of completion.

The core of measures in the Czech Action Plan were proposed by license holder ČEZ, a.s. and accepted by SÚJB (State Office for Nuclear Safety) as nuclear safety regulatory authority. Both the Dukovany NPP and Temelín NPP developed so called Safety Increasing Program (SIP) based on conclusions of the National Stress Tests Report, lessons learned from EU stress tests peer review exercise and previous periodic safety review findings. This initiative is in line with the licensee's prime responsibility for safety principle defined in the Czech law. After regulatory review the licensee list has been supplemented by measures/actions requested by SÚJB. This Action Plan represents the complete set of measures (as of 31st December 2012) to strengthen the safety of Czech nuclear power plants in response to the Fukushima nuclear power plant accident. Based on article 17 of the Atomic Act in force at that time this final version of the Action Plan has been transferred to the licensee ČEZ, a.s. via letter of SÚJB Chairperson together with the description of procedure that is being applied for regulatory oversight of its implementation. In particular, implementation of this Action Plan will be continuously monitored through scheduled inspections. If needed, new measures will be included or modification of already existing measures will be done in accordance with principles mentioned in previous paragraph.

Both the Czech Action Plan and the conclusions of SÚJB inspections are published on the SÚJB website.

## **Finland**

The status of the activities is updated and represents the situation in December 2019.

Some of the most significant plant changes which have been implemented include:

In Loviisa NPP:

- enhanced protection against high sea water level
- independent air-cooled cooling units for decay heat removal from the reactor core and from the spent fuel pools in case of the loss of sea as an ultimate heat sink

In Olkiluoto units 1 and 2:

- diverse cooling of the spent fuel pools
- ensuring operation of the auxiliary feed water system pumps independently of availability of the sea water systems
- independent way of pumping water into the RPV in case of total loss of AC systems

Some issues have been revisited, including:

- Acquiring mobile power supply and mobile pumps and improving the containment decay heat removal in the case of multi-unit accidents at the Loviisa NPP. Using additional mobile power supply and mobile pumps have been evaluated by the licensee (Fortum) and it has been decided that usage of such equipment would not fulfil national regulations. Finnish regulations require fixed installed systems for residual heat removal from the fuel in the reactor for a period of three days, independently of the off-site supply of electricity and water in a situation caused by a rare external event or a disruption in the on-site electrical distribution system. Also, for severe accident management, there shall be fixed installed systems that are independent of the systems designed for normal operation, anticipated operational occurrences and postulated accidents. Diverse residual heat removal of spent fuel from storage pools can after a grace period rely on mobile equipment with fixed supply connections. Autonomy requirement is the same as in case of residual heat removal from the reactor.
- Planned launch of a National Nuclear Power Plant Emergency Preparedness Forum was cancelled, since after the initial proposals, the Forum's field of responsibility was found to be mostly overlapping with other existing co-operation and co-ordination bodies. Therefore, it has been decided that creation of new group is not the best way to address the issue. Instead, the membership and responsibilities of existing groups have been adjusted.

There is only one remaining action at the operating NPPs which has not yet been finalized: ensuring the water injection into the spent fuel pools and monitoring the conditions of the pool at the Loviisa NPP. Original target date for implementation was 2018. Due to many overlapping plant modifications (I&C renewal, improvement of secondary circuit safety functions), the licensee had to make the decision to postpone Fukushima modification finalization to 2020. There is also one action concerning Olkiluoto unit 3 under commissioning which will be resolved after the provisional takeover: implementation of the strategy for restoring long-term cooling after an extreme electrical disturbance by replacing selected parts of the electrical systems.

## France

As described in the last update of the national action plan (December 2017), the French regulator (ASN) issued a number of prescriptions (around 35 per NPP) to increase plant robustness and safety. These prescriptions address the issues identified by the peer review on the European stress tests and even go beyond.

They led to the implementation of the following modifications on the French NPPs:

- reinforcement against internal and external hazards: implementation of reactor trip in the event of an earthquake, reinforcement of protection against flooding;
- additional electrical power supply means: installation of additional electrical power supply (backup diesel-generators), increase of the autonomy of the batteries used in the event of complete loss of electrical power supply;
- additional prevention means: e.g. installation of high-temperature reactor coolant pump seals capable of withstanding loss of cooling for an extended period to ensure simultaneous injection at the RCP seals on two neighbouring reactors of the 900 MWe plant series, complementary emergency water supply resources, complementary instrumentation of the fuel storage pool and its building, strengthening of on-site emergency equipment (pumps, generator sets, hoses, etc.), provisions to prevent accidental rapid draining of the fuel storage pools, installation of standardized external pipe connections for mobile equipment (particularly for the FARN, see below);
- enhanced severe accident management: e.g. redundancy of instrumentation for detecting reactor vessel melt-through and hydrogen in containment, storage of mobile means, nuclear rapid intervention force (FARN) with the capacity for simultaneous intervention on all reactors of an accidented site in less than 24 hours. The FARN provides water, compressed air and electricity supply with its own mobile equipment;
- reinforced crisis management: reinforcing the earthquake resistance and flood resistance of the emergency management premises, reinforcement of team preparation in the event of an earthquake, measures to cope with site isolation in the event of flooding, reinforcement of the means of communication, multiple unit plant



emergency organization, coordination with neighbouring industrial operators in the event of an emergency.

These modifications allow to respond to the recommendations from the peer review on the European stress tests.

Besides, using as a reference the safety objectives of Generation III reactors, additional modifications will be implemented in the French NPPs in the frame of the continuous improvement.

### **Germany**

The fourth and final updated German National Action Plan (NAcP) was published in February 2018. The NAcP for measures in the nuclear power plants was prepared by the BMUB in collaboration with the regulatory authorities of the Länder. The NAcP contains the national recommendations from a GRS Information Notice and from all RSK Recommendation as well as RSK Statements related to Fukushima. The implementation of most corresponding measures was reported by the operators until the end of 2014. The BMUB asked the Reactor Safety Commission (RSK) in 2014 to perform a generic review of the implementation status of the national recommendations included in the NAcP. This generic review by the RSK was finished in November 2017. No further generic recommendations have been identified during the process. Remaining plant specific topics will be addressed within the regular oversight of the Länder authorities.

### **Hungary**

The HAEA reviewed the Action Plan again in December 2019 and the updated NAcP was published in December 2019. The purpose was to describe the status of the actions at the end of 2019. According to the results and to the status in the end of 2019 most of the actions included in the Plan have already been implemented in the Paks NPP. 46 out of the 51 tasks have been completed and closed.

The most significant already implemented measures are the following:

- Reinforcement of the building of demineralised water tanks in Installation II.
- Installation of automatic shutdown to the main condenser coolant pumps in the case of damage of pipeline due to earthquake or other reason. Measures against internal flooding installed.
- The existing symptom-based emergency operating procedures reassessed and supplemented.
- The potential setting of the boron concentration of water inventories from external sources and its storage solved.

- Access to the connection point of the auxiliary emergency feedwater system in accident conditions improved, new connection points established on the demineralised water tanks.
- The black-start capability (start-up from own diesel generator) created for the Litér gas turbine.
- Cross-links provided safety electrical power supply from any operable emergency diesel generator in any unit to the safety consumers of any other unit.
- Hydrogen monitoring system installed as part of the severe accident instrumentation for units 3 and 4.
- A new water supply route connected in the courtyard by flexible means constructed that is protected from external hazards (such as earthquake). The spent fuel pool shall be filled from the borated water reserve specified previously via this line.
- Corresponding to management of severe accidents, for the construction of an external water supply route to the auxiliary emergency feedwater system, the equipment necessary for the connection of external origin mobile diesel generators and pumps to the systems purchased.
- The training and exercise of multi-unit emergencies was performed.
- A shielded transport vehicle deployable at significant radiation levels procured.
- Air-conditioning of the Protected Command Centre re-assessed and an appropriate power equipment installed that can also be supplied by diesel generator

The delayed actions:

5 tasks have been rescheduled due to delay in the implementation. The new deadlines were determined by the PSR closure decision of HAEA, taking into account the calculated additional risk. Concerning the delayed tasks, the HAEA requested safety assessments from the operator of Paks NPP, based on which further actions were not justified. Altogether, the safety margins of Paks Nuclear Power Plant are further strengthened by the incorporation of the experience from the Fukushima accident, while its capabilities of managing extreme situations of very low probability improved. In the closing decision of the Periodic Safety Review HAEA maintained the need to implement ongoing measures and has set the new deadlines. They are the following:

1. **Task 1.2:** The fire station building must be reinforced in order to protect the stuff and equipment even in safety earthquake. The old building shall be reinforced instead of constructing a new building according to the NPP's decision. The design technical specification was finished, the cross checking and approval process is underway. After having these successfully finished, the public procurement process can begin.

**New deadline:** 31.12.2021

**Safety justification:** With the reinforcement of the fire station, the core damage frequency would drop by 9.4%. Therefore the risk reduction loss due to

implementation delay falls into range of  $4.93E-07$ . According to these it can be stated, the risk reduction loss due to the 3 years delay has a conservative maximal value of  $1.5E-06$ . It is tolerable according to the safety analysis.

**Reason of deadline modification:** Until 2017 the project had been preparing the construction of a new fire station. After two unsuccessful public procurements the licensee returned to the original concept to reinforce the existing building. In 2018 a totally new investment program started with another technical scope. The new implementation plan has been finished in 2019 summer and the licensing began.

- **Task 1.12:** Proper diesel generators shall be installed, that are protected against outer hazards (earthquake, extreme weather conditions, flooding) and are independently (from other water and electric power supply systems) operable. The diesel generator design bases cover these conditions: it must be capable to supply all the necessary consumers in each case, when the total loss of onsite electric power must be taken into account; it must be assumed, that several or all the units are affected concurrently in the accident; the cooling requirements of the reactor and the spent fuel pool is taken into account; they are available even in cases beyond the load of the existing emergency diesel generators; fulfilling the long term functions of the emergency diesel generator, i.e. it is capable to operate beyond the operation time of the emergency diesel generator.

**New deadline:** 31.12.2021

**Safety justification:** The estimated risk reduction effect of the new, severe accident diesel generators is equal to  $6,23E-07$ , the effect of long term containment cooling, in case of nominal power internal initiating events and hazards. The risk reduction loss due to the 3 years delay of modification has a maximal conservative value of  $1.9E-06$ . It falls into the range of tolerable risk according to the safety analysis.

**Reason of deadline modification:** The manufacturer selected previously announced, it did not want to supply diesel generators for NPPs due to divesture. Even so the company took on to deliver 2 diesel generators with the help of Rosatom. But the manufacturer had such contract modification demands and required such technical conditions (installing, testing, etc.) that made the project impossible, because the parameters do not fulfil the technical specification based on TSR prescription. A new contract was signed with a Hungarian main contractor in 2017 to purchase 2 pieces of 2 MW emergency diesel generator.

2. **Task 1.25:** A system must be implemented that prevents the slowly up building, design pressure exceeding pressure to occur. An agreement was made with the main contractor. The design process is finished. The regulatory license issued in December 2019.

**New deadline:** 31.12.2021

**Safety justification:** The expected frequency of large radioactive release without containment cooling is  $9.62E-07$  1/year, with cooling, thus with the implemented task it is  $3.39E-07$  1/year. The risk reduction effect of long term cooling, the drop of large radioactive release frequency is  $6.23E-07$ . The conservative value of risk

reduction loss due to the 3 years long modification delay is  $1.9E-06$ , which falls into the highest bearable risk range.

**Reason of deadline modification:** The design of protection against containment overpressure has been modified several times in the recent years. There has not been any agreement on if the containment cooling would be implemented with 1 or 2 circuit cooling. The concept was changed in 2017 and contract was signed with the main contractor. The construction works can be performed only during main outage, therefore they will start at the beginning of 2020.

3. **Task 1.28-29:** Construction of a Backup Emergency Command Centre (BECC) equal to the Emergency Control Building. During the licensing of BECC construction and modification the completion of documentation was fulfilled, the necessary licenses from separate authorities had been released. The public procurement process on construction was finished, but the cost is debated with the main contractor, that sets back the project. As part of the task, also the BSCC related part of task 1.31 is set back, that obligates the implementation of mirrored storage system equal to the one in Emergency Control Building.

**New deadline:** 31.12.2022.

**Safety justification:** The use of Backup Emergency Command Centre (BECC) becomes important during the management of beyond design bases events. According to the presumption after the work got impossible in the Emergency Control Building following the moving to BECC the Technical Support Centre could continue to fulfil its function: the necessary accident management measures. If we assume, the functioning of a full BECC means the reliable TSC operation, then its importance can be measured by the change of large radioactive release frequency. The risk reduction effect of the BECC existence would drop  $3.63E-07$  1/year, but due to the 3 years delay the lost risk drop would be  $1.5E-06$  with conservative approach.

**Reason of deadline modification:** The Backup Emergency Command Centre was originally designed for 6 units, but the requirements related to new units sets higher seismic criterion. As the present task belongs to the existing and operating units, new design was made. The construction works started in 2019 on its base.

4. **Task 1.30:** The 2017 April modification of Govt. Decree 346/2010 obligates the Licensee to use the Unified Digital Radio Communication System to implement wireless communication. The technical specification had been determined. The development plan is ready and had been approved by the authorities. The public procurement process is under way.

**New deadline:** 31.12.2021.

**Safety justification:** The design bases accidents are managed by the staff with the operating safety systems and operating instructions. The communication equipment used already by the personnel are included by the human failure model of the safety analysis. The task delay is not demonstrable in CDF. Wireless communication can be provided with the satellite telephones being in purchase. The expected frequency of large radioactive release and core damage does not change due to UDR implementation according to the safety analysis.

**Reason of deadline modification:** There was no agreement between the Licensee and the communication services provider on the use of the nuclear safety and physical protection requirements. The progress is in several years delay due to the multiple modification of Govt. Decree 346/2010 affecting heavily the project. The third public procurement process, conducted in 2018, was successful, and the construction will have been finished by the end of 2021 the latest.

The implementation status of the NAcP actions is monitored by the HAEA as part of yearly inspections. The HAEA pays specific attention to the delayed tasks. In most cases, the time demands and the rules of public procurement procedures have a major role in the delay.

### **Lithuania**

All measures of the Lithuanian national action plan, which includes 14 measures, have been completed. The Final Report on Implementation of Lithuanian National Action Plan, available to ENSREG, has been published in May 2018.

Measures related to nuclear safety of Ignalina NPP Units and Interim Spent Fuel Storage Facility were implemented in 2015. Implemented measures provide increased capabilities of Ignalina NPP to manage very unlikely (beyond design basis) accidents. The implemented measures include:

- Installation of the new water level measuring equipment for beyond design basis accident conditions in spent fuel pools of Unit 1 and Unit 2. This equipment will allow Ignalina NPP staff to monitor water level in spent fuel pools during the accident and to make necessary decisions to manage such a accident as well as to mitigate its consequences;
- Installation of special power sockets for emergency mobile diesel generators connection in different places of Ignalina NPP building. This improvement will allow to increase robustness of power supply for necessary equipment in case of loss of all power supply sources foreseen by Ignalina NPP design;
- Assessment of the robustness and availability of the Ignalina NPP Accident Management Centre for beyond design basis earthquake. The result of assessment confirmed the robustness and availability of the Accident Management Centre in case of earthquake with peak ground acceleration 0,13g;
- Assessment of the capabilities of design equipment (water temperature and level as well as radiation detectors instrumentations) in the spent fuel pools and spent fuel pools halls of Units 1 and Unit 2 for conditions similar to beyond design basis accidents conditions. As a result, relevant emergency preparedness instructions of Ignalina NPP have been updated.

Other safety improvement measures dealing with enhancement of Ignalina NPP Units and Interim Spent Fuel Storage Facility safety are described in the Final Report.

The last two Lithuanian National Action Plan's measures have been completed as of 20 March 2018. These measures were related with review of WENRA documents – WENRA Safety Reference Levels for existing reactors, published in 2014, and WENRA specific guides related with natural hazards analysis, published in 2016, and consequent transfer to national legislation provisions still relevant to Ignalina NPP under decommissioning. In 2017, VATESI completed review of the above mentioned WENRA documents, identified relevant provisions and prepared amendments to Nuclear Safety Requirements BSR-2.1.2-2010 “General Regulations on Safety of NPPs with RBMK-1500 Reactors”, which were approved on 20 March, 2018.

## **Romania**

The status of the actions reflects the situation as of December 2019. CNCAN monitors the licensee's progress in the implementation of the planned improvements and continues to perform safety reviews and inspections to ensure that all the opportunities for improvement are properly addressed taking account of the lessons learned from the Fukushima accident. All measures have been implemented, with the exceptions of new seismically qualified location for the on-site emergency control centre and for the fire fighters, and modifications to penetrations sealings.

All the most important safety-related upgrades have been implemented. There is a delay in the implementation of Action #31 (Cernavoda NPP will establish a new seismically qualified location for the on-site emergency control centre and the fire fighters. This location will include important intervention equipment (mobile diesel generators, mobile diesel engine pumps, fire-fighter engines, radiological emergency vehicles, heavy equipment to unblock roads, etc.) and will be protected against all external hazards.) This action is in progress and it is estimated to be completed by the end of 2020. The target date for implementation has been changed several times due to legal and administrative issues related to transfer of property of the physical location. Until the completion of this action, equivalent measures have been implemented to ensure that all intervention equipment (mobile Diesels, Diesel fire pump, fire trucks, etc.) are protected from external hazards (e.g. the equipment have been relocated so that they would not be impaired by external events). Concerning the modifications to penetration sealings, all originally identified targets have been modified but the scope of work has been extended. Delay has been caused by the complexity of the found solutions to improve the sealings. Target for completing the modifications is July 2020.

## **Slovakia**

Almost all measures listed in the NAcP are completed. The remaining ones are in an advanced stage of implementation.

Majority of tasks resulting from the NAcP are covered by regulatory decisions issued before Fukushima and in particular after the periodic safety assessment of NPPs in the years 2008 (NPP Bohunice) and 2011 (NPP Mochovce). According to these decisions the operator was obliged to report to UJD SR on the progress and the results achieved annually. The regulator

(UJD SR) performed inspections within its annual inspection plans the aim of which were to monitor the implementation of measures.

The inspection results confirmed the operator's overall compliance with the National Action Plan in terms of substance and deadlines as well. Some measures have been completed before deadline. The previously identified delays related to verification and validation of severe accident management guidelines (SAMGs) were resolved during 2018 and the verification and validation of SAMG were completed for the operating units.

Status of ongoing activities:

Units Bohunice 3 and 4:

ID 3 - Prevention of accidents because of natural risks and limitation of their consequences. The remaining activity concerns risks caused by strong wind. The relevant design modification documentation was developed by the licensee. The implementation has been rescheduled.

ID 31 - Bunkered/Hardened systems Original project documentation for sheltering of mobile DG and cabling was revised. New location for the placement of mDGs was selected to avoid impact of surrounding buildings. The mDGs are now placed in an existing seismically reinforced building within the site.

Units Mochovce 1 and 2:

ID 3 - Prevention of accidents because of natural risks and limitation of their consequences. In 2018 delays in the completion of seismic reinforcement of units EMO1 and 2 were identified by UJD and confirmed by the licensee. During the early phase of the project, several contractors were changed for different reasons (e.g. not using acceptable methodologies - specific GIP VVER methodology or difficulties in providing the complete Safe Shutdown Equipment List (SSEL). The SSEL after an earthquake was finally developed during 2017 – 2018 by a group of contractors. The assessment of seismic capacity of SSC which are on the SSEL list is ongoing.

In parallel to the assessment of seismic capacity of SSC, seismic reinforcement of buildings/structures have been completed or is ongoing (e.g.):

- Fire station building – completed
- Emergency feed water system - completed
- Emergency Response Centre – completed
- Air duct to venting stack - completed
- Venting stack - completed
- Diesel Generator Station – ongoing

- Diesel oil system – ongoing
- Central pumping station of Essential Service Water - ESW and firefighting water - completed
- Forced draft cooling towers of ESW system - completed
- Nuclear auxiliary service building - ongoing
- Etc.

From the procedural aspect the application of the Act on Environmental Impact Assessment in conjunction with the administrative proceedings under the Atomic Act, Construction Act, Act on Administrative Order and particularly the Act on Public Procurement significantly influencing (extending) the implementation of safety enhancement projects.

Based on these facts and taking into account the complexity of the project on seismic reinforcement the regulator accepted the proposal of the licensee to extend the date for the completion of seismic reinforcement until 2022 provided that the licensee will provide reports to UJD on the status of implementation and planned measures on annual bases.

In the above-mentioned cases UJD SR apply a more thorough review of the progress made supported by in depth inspections annually.

## **Slovenia**

The Slovenian Post-Fukushima National Action Plan (NAcP) is divided into two main parts. The first part are the hardware improvements of the Krško NPP (the only NPP in Slovenia) (including procedure and safety analysis upgrades), comprising the Krško NPP's Safety Upgrade Program (SUP) approved by the Slovenian Nuclear Safety Administration (SNSA) in 2012. The Krško NPP's SUP is divided into three phases.

Phase I was implemented in 2013:

- installation of passive autocatalytic recombiners (PARs) and installation of a containment filtered vent system (SUP action 1.5).

Phase II was to be implemented by the end of 2019, yet some parts of it are delayed. It includes:

- additional flood protection of the nuclear island and all the new systems, structures and components (SUP action 1.9 - implemented in 2015/2016);
- installation of pressuriser bypass relief valves, qualified for severe accidents (part of SUP action 1.4 - implemented in 2018);
- installation of a fixed spray system on the spent fuel pool with provisions to use mobile equipment (SUP action 1.7 - implementation delayed to 2020 due to needed redesign and implementation of other tasks with higher priority);



- acquisition of a mobile heat exchanger with provisions for quick connection to the spent fuel pool (SUP action 1.8 - implementation due to needed redesign and implementation of other tasks with higher priority);
- installation of an additional heat removal pump (ARHR) with a dedicated heat exchanger capable of removing heat from the primary system and the containment. This improvement was to be implemented completely in last year's refuelling outage (October 2019), but the delivery of the main component (the ARHR pump) by the supplier was delayed (part of SUP action 1.4 - delayed to 2021);
- upgrade of the bunkered building 1 (BB1) electrical power supply: provisions to connect mobile diesel generators, seismic requalification, installation of the battery with 24-hour capacity, etc. (SUP action 1.1 - implemented in 2018);
- installation of the emergency control room (ECR) in the BB1 protected against external hazards and severe accident's radiation with capabilities to shut down the reactor and maintain the long-term safe shutdown state. This improvement also includes installation of severe accident instrumentation (SUP action 1.6 - implemented in 2018/2019).
- upgrade of the operational support centre (OSC) and technical support centre (TSC) (emergency centres) to ensure a safe long-term environment for operators even in the event of severe accidents. Both, OSC and TSC are around 90% complete (SUP action 1.10 - implementation delayed to 2020 due to other tasks with higher priority);

Phase III improvements are underway and are to be completed by the end of 2021:

- installation of additional injection systems for the reactor cooling system / containment and steam generators with dedicated reservoirs of cooling water (also borated) capable of being replenished with water from underground wells - the bunkered building 2 (BB2) project (SUP action 1.2 and part of 1.4 - implementation underway);
- construction of a dry spent fuel storage facility (SUP action 12 - implementation underway).
- The original deadline for the SUP was 2016 but was delayed. Most delays were caused by the public procurement process due to which most of the projects' biddings had to be repeated. Additional delay was caused by the owners of the plant, which at one point were considering the financial viability of the plant's life time extension and implementation of the SUP (described in more details in December 2017 NAcP update). By the end of 2019 around 92% of the SUP was implemented. The Krško NPP's SUP is on schedule to be implemented by the end of 2021.

The second part of the Slovenian NAcP are so called soft improvements, such as revising the legislation, enhancing emergency response and cooperation with neighbouring countries,

performing additional inspections and studies, inviting and hosting peer review missions, and upgrades of PSA analyses. Couple of these actions are still underway, such as the revision of the national emergency response plan, upgrade of spent fuel pool PSA, and invitation of the IAEA RAMP mission (Review of Accident Management Program), which will be the last action to be implemented, expected in 2022 after the completion of the SUP.

## **Spain**

In response to the accident occurred on March 11th 2011 at the Fukushima Daiichi NPP in Japan, all the European countries carried out actions aimed at verifying and improving the safety measures in place at their plants. This effort was fostered and coordinated by ENSREG, which established the need of all the European countries owning nuclear installations to develop an effectively implement the corresponding National Action Plan (NAcP) to follow up the practical and on-time implementation of the commitments established after the European Stress Tests.

According to this ENSREG approach the CSN developed the country NAcP, affecting all the Spanish NPPs. The NAcP has been the subject of an intense process of evaluation and supervision by the CSN along these last years.

The main conclusion of this revision 2 of the NAcP is that most of the actions anticipated in the Plan have been already implemented in the NPPs. National regulation has been modified according to WENRA Reference Levels issued after the Fukushima accident, except for issue “T” that is pending and CSN is currently working on it.

## **Sweden**

In general, the Swedish national action plan required extensive initial investigations to be performed, with the aim to identify and evaluate necessary technical and administrative measures, to define how to implement them and the associated appropriate time schedules. The measures listed in the Swedish national action plan were scheduled in three different categories, 2013, 2014 and 2015, corresponding to the year when the measures were expected to be completed. This categorization was based on an assessment of the urgency of the implementation of the measures as well as of their complexity.

Due to the complexity of some of the major technical and administrative measures identified in the investigations initially performed, they were scheduled to be implemented after 2015. However, according to the Swedish national action plan, all necessary measures resulting from the investigations, both technical and administrative, were to be fully implemented by the end of 2020.

New Regulations Concerning the Design and Construction of Nuclear Power Plants came into force on 1 January 2005 (current designation SSMFS2008:17). These regulations also include requirements related to the resistance of an NPP to extreme external events. As a result of safety improvements prompted by SSMFS2008:17, several measures taken to strengthen the

resistance to extreme external events had already been initiated when the NAcP was developed.

The Swedish Radiation Safety Authority (SSM) has continuously performed reviews and follow-up of the licensee actions concerning the Swedish national action plan. So far, all measures identified and specified in the national action plan have been completed according to the given time schedule, and the 2020 deadline is expected to be met. Thus, the implementation of the remaining measures at all sites will be completed at the latest in 2020, when the Independent Core Cooling (ICC) system will also be in place.

The installation of a robust ICC system is a major technical measure that, according to license conditions issued by SSM in 2014, is required to be in place by the end of 2020 at all Swedish NPPs that are planned to be in operation after 2020. The license conditions included an intermediate requirement, where the independence of core cooling was required to be considerably improved by the end of 2017. The intermediate condition has been fulfilled for all operating reactors, and the construction tasks and component manufacturing for the ICC systems are in progress at all affected plants.

### **The Netherlands**

The License Holder's action plan was approved by the regulatory body in 2012 and the License Holder was required to send progress reports every three months. The regulatory body assesses each of the modifications and verifies implementation and progress by inspections. Any delay from the agreed schedule had to be justified formally and agreed with the regulator.

In January 2020 all NPP actions were completed. Further updates on a limited number of the other actions will be provided through the process of the Convention on Nuclear Safety (CNS). Further details are given below.

By January 2020, all 46 stress test Actions to be executed by the License Holder have been completed. Some examples of significant safety improvements are the following:

- In Vessel Metal Retention by installing a cooling circuit to cool the outer part of the reactor vessel
- Additional mobile equipment and related connection points to increase options to provide electricity and cooling water, including storage protected against external hazards
- Several reinforcements related to increased level of earthquake
- Measures to reduce the risk at mid-loop operation of the primary cooling system with open vessel
- Several improvements of EOPs and SAMGs, including Implementation of SAMG for spent fuel pool

- Several improvements of Emergency Preparedness and Response

Also almost all non NPP related actions in the action plan are closed. There is a limited number of three actions about which The Netherlands will further report progress through the process of the CNS. Two out of these three are actions came from the 2014 IRRS mission and were added to the NAcP in 2014 and closed on the basis of progress made and confidence in its completion during the IRRS Follow-up mission in 2018. There is only one action, included into the NAcP from the IAEA-Action plan, remaining: a decision about an EPREV mission. This is a National decision that needs thorough interdepartmental coordination, preparation and planning, including coordination with the other large missions to come in the next few years (IRRS, ARTEMIS, IPPAS). The decision process started in 2019, but will take at least 2020. Also for this action further updates will be given through the process of the CNS.

### **United Kingdom UK**

In December 2017, ONR issued a report setting-out progress against the UK's 'National Action Plan' (NAcP). Overall, ONR is satisfied that EDF Energy Nuclear Generation Limited has addressed the learning from Fukushima. All findings and recommendations associated with the UK's NAcP were considered closed in 2015. However, ten recommendations were made for additional work at that point. The scope of these recommendations included:

- Additional analysis of flooding data for operating reactor sites.
- Completion of studies to evaluate beyond design basis margins for external hazards.
- Additional validation of plans and arrangements for deployment of back-up equipment.
- Implementation of routine deployable back-up equipment training and exercise programmes.
- Further work to underpin level 2 PSA studies against characteristics of each AGR site and consideration of development of a level 2 PSA for Heysham 1 / Hartlepool.

ONR's 2017 update of the NAcP reported progress against these recommendations which were regarded by ONR as normal business, monitored through routine ONR processes. Work to address the additional recommendations has now been satisfactorily completed. ONR delivered a presentation to the January 2019 meeting of ENSREG WG1 setting out the scope of work undertaken, which together with the 2017 updated NAcP, provided the basis for peer review by common discussion.

### **Switzerland**

ENSI published its final report on the Swiss Fukushima Action Plan in December 2016. This final report presents the status of the main topics for investigation, grouped into the following themes:

- Protection against natural events and the loss of fundamental safety features
- Severe Accident Protection (Severe Accident Management)
- National emergency management
- National supervision
- International cooperation

Overall, it should be noted that the studies planned in the Fukushima action plan with the identified 20 priorities are all complete. A major part of the remedial measures derived from the studies have already been completed. However, the following remedial measures have not yet been completed:

- One-off retrofits within the nuclear power plants in Switzerland to increase protection against natural events and major accidents,
- Establishment of off-site emergency response rooms;
- Updating of the threat assumptions on extreme winds and temperatures;
- Improving the local dose rate measurement system and implementing a specially protected communication system to improve emergency management;
- Adjustments to various Regulations in order to lay down statutory measures in the area of emergency management.

The implementation of these measures, with the exception of the latter point, will be followed up by ENSI in the context of the regulatory process and will be coordinated with other federal agencies and will take a number of years. ENSI will report on the implementation of the actions as part of its annual supervisory reports.

## **Ukraine**

In June 2011, Ukraine joined the European initiative of conducting stress tests at nuclear power plants in EU member states and neighbouring countries (Stress Test Declaration). The stress tests were performed at Ukrainian NPPs in compliance with the stress test specifications agreed by the European Commission and ENSREG.

In 2020, the National Action Plan was updated. Several measures have been implemented, including e.g. spent fuel pool and steam generators makeup and cooling in long-term station blackout conditions, improved reliability of emergency power supply, development of symptom-oriented emergency operating procedures for management of design-basis and beyond design-basis accidents (low power and shutdown states), developing severe accident management guidelines, and improving habitability of the main control room and the emergency control room in design-basis and beyond design-basis accidents (installation of iodine filters). There are also some measures that are still ongoing, including e.g. seismic resistance of structures, systems and components important to safety, replacement of self-contained air conditioners seismically qualified, development and implementation of

hydrogen mitigation measures for beyond design-basis accidents, implementation of a containment venting system, and analysis of the need and possibility to qualify components that may be involved in severe accident management for harsh environments.. A series of measures included in the National Action Plan are implemented in the framework of the Comprehensive (Integrated) Safety Improvement Program for Ukrainian NPPs (C(I)SIP). The program was extended by the Cabinet of Ministers of Ukraine in 2019 until 2023 because of delays in obtaining the EBRD/Euratom loan for partial funding of C(I)SIP, difficulties in tenders for equipment purchase and expansion of the program with post-Fukushima measures. New measure 'Implementation of a Reactor Pressure Vessel External Cooling System' was added to the National Action Plan in 2020 for VVER 440-213 reactors. The deadline of the new measure is December 31, 2021. Analysis of the strategy for possible corium confinement within the reactor pressure vessel are continued for the other reactor types.