



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

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### Introduction

Following the European stress tests requested by the European Council as a 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 ENSREG 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. 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 over the years. 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 were, or 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
- Extensive changes are made to the original, conceptual plans, for example extending the original scope to cover more facilities, including new-builds
- 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 lead to a delay to the next reactor outage
  - Events 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. In summary, altogether there are only a few ongoing actions, in 6 countries. The current schedule is such that most of them should be finalized by end of 2022, with a few extending to 2023 or 2024.

Opportunities for further safety improvements are identified as part of continuous improvement process, e.g. in periodic safety reviews and international peer reviews. Some countries have opted to report about these actions too, although the actions are not directly Fukushima-related. For that reason, some countries have described further updates in this report, even if all the original Fukushima-related actions have been completed and the closure report has been issued.

## **Belgium (closure report issued)**

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 reevaluation 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 December 2021. 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 – 75 measures (96%);
- Under implementation – 3 measures (4%).

The remaining 3 measures are in an 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 2022. Their status is as follows:

1. Construction of Kozloduy NPP off-site Emergency Response Centre (ERC), new term extends to December 2022:

This measure is in progress and according to the new term it is estimated to be completed by the end of 2022. 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. Since 2020, the COVID-19 pandemic has slowed down the work.

2. Installation of measuring channels to monitor and evaluate the concentration of steam and oxygen in the containment, new term extends to August 2022:

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. The system has been installed and commissioned at unit 6. At unit 5, commissioning tests revealed need for some further work, which will be performed during the annual outage in 2022.

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. During the planned annual outages in 2021, the installation of the system was completed at Unit 6 and most of the planned activities have been implemented for Unit 5. At unit 5, finalisation of the work has been delayed as the COVID-19 pandemic has hampered the manufacturing of the equipment and materials needed. The remaining work can only be carried out during annual outage and it will be completed by the end of June 2022.

## **Czechia**

According to the updated report available to ENSREG (from February 2022), 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. ČEZ, a.s. 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. At present and in relation to the mentioned project changes, ČEZ, a.s. is evaluating relevant incoming offers for implementation. The schedule for the completion of the project changes is the end of 2024.

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 principle of the licensee's prime responsibility for safety defined in the Czech law. After regulatory review the licensee's 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 (closure report issued)**

The Finnish national action plan has been completed. The closure report on Implementation of the action plan, available to ENSREG, has been published in March 2021.

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
- diverse cooling of the spent fuel pools

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 were cancelled after reconsideration, 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 use 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.

For Olkiluoto unit 3, implementation of the strategy for restoring long-term cooling after an extreme electrical disturbance by replacing selected parts of the electrical systems will be performed after the provisional takeover. The action was not directly related to Fukushima stress tests but to the Forsmark incident in 2006. STUK has approved the implementation concept. STUK will follow the activity by normal regulatory oversight processes.

## France (closure report issued)

The actions of the French national action plan have been completed. The closure report on Implementation of the action plan has been published in December 2020 on the public ENSREG website.

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 (closure report issued)**

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 and published the updated NAcP in December 2021. The purpose was to describe the status of the actions at the end of 2021. According to the results and to the status in the end of 2021 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:

In 2018 the HAEA rescheduled the remaining tasks in the final PSR decision. The final deadline of these tasks was 31 December 2021, except for the implementation of the Backup Emergency Control Building (BECB) (TSR-1), for which the deadline is on 31 December 2022. The status of the tasks in December 2021 was the following:

- Implementation of Unified Digital Radio Communication System (TSR-2): The deadline (31.12.2021) can be met, commissioning will be postponed to the first half of 2022.
- Installation of severe accident diesels (TSR-4) is not completed. The diesels have been procured and transported to the site, the condition of the diesel generators is checked every six months, and the commissioning of the Southern site will be postponed to the first half of 2022. The North site will be completed with a half-year lag.
- Spray system to prevent slow pressure build-up exceeding design pressure (TSR-5) is installed on Unit 3. The commissioning test will be performed at the next overhaul in February 2022. This system can be used as a reference for the deployments on the other units.
- The construction of the earthquake-resistant fire barracks (TSR-3) will not be completed on time. The authority will review the status of the overdue task in an officially induced procedure.
- Implementation of the Backup Emergency Control Building (TSR-1): Construction has been completed in October 2021, and the installation of I&C and mainly the mirror storage facilities is expected to be completed and the facility commissioned by the end of 2022.

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 (closure report issued)**

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 2021. 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 firefighters. This location will include important intervention equipment (mobile diesel generators, mobile diesel engine pumps, fire 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 2024. 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 (Action #5), all originally identified targets have been modified but the scope of work has been extended as additional improvement opportunities have been identified. The improvements are under implementation.

## **Slovakia**

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

The 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 action was completed in January 2022.

ID 31 - Bunkered/Hardened systems. Original project documentation for sheltering of mobile Diesel Generators (mDGs) and cabling was revised. New location for the placement of mDGs was selected to avoid impact of surrounding buildings. The mDGs were temporarily placed in an existing seismically reinforced building within the site. The construction permit for the new shelter was issued by UJD in 2021 and the action was completed in January 2022.

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 (since 2019 e.g. the diesel generator station, nuclear auxiliary service building) 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 – completed
- Diesel oil system – completed
- Central pumping station of Essential Service Water - ESW and firefighting water - completed
- Forced draft cooling towers of ESW system - completed
- Nuclear auxiliary service building - completed
- Reactor building of EMO12 - ongoing
- Electrical switchboards - 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 are 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 (closure report issued)**

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 were 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 – implemented in 2020);
- acquisition of a mobile heat exchanger with provisions for quick connection to the spent fuel pool (SUP action 1.8 – implemented in 2020);
- installation of an additional heat removal pump (ARHR) with a dedicated heat exchanger capable of removing heat from the primary system and the containment (part of SUP action 1.4 – implemented in 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 (SUP action 1.10 – implementation finalised in 2021);

Phase III improvements underway or 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 – implemented in 2021);

- 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 lifetime extension and implementation of the SUP (described in more details in December 2017 NAcP update). The construction of the storage facility is ongoing. The dry storage building and all the necessary infrastructure is expected to be completed in the second half of 2022.

All of the original SUP improvements have been completed. The construction of the dry spent fuel storage is an additional action and also it is close to completion.

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. Most of the original actions have been implemented, with a few of them still in progress (e.g. developing external hazard PSA for SFP). Anyhow, SNSA sees these actions as part of continuous improvement process, as most of them repeat in time with new knowledge and new possibilities for improvements.

The closure report on implementation of the action plan has been published in December 2021.

### **Spain (closure report issued)**

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 years.

All actions included in the Spanish NAcP have been already implemented in the NPPs. The closure report on the implementation of the action plan has been published in 2017.

Spanish 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. The work is forecasted to be completed within 2022, when the new safety instruction on

'characterization and site evaluation for nuclear installations' will be finally approved. The provisions of the reference levels have been effectively incorporated in the design of all the nuclear power plants in operation in Spain, but their incorporation into the Spanish regulatory standards is not yet completed due to the lengthy approval process, including internal, external and public consultations.

### **Sweden (closure report issued)**

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. All measures identified and specified in the national action plan have been completed according to the given time schedule.

The installation of a robust Independent Core Cooling (ICC) system is a major technical measure that, according to license conditions issued by SSM in 2014, was 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 was fulfilled for all operating reactors, and the ICC systems have now been implemented at all affected plants, according to the set time schedule. A closure report on implementation of the action plan, available to ENSREG, was published in January 2022.



### **The Netherlands (closure report issued)**

The License Holder's action plan was approved by the regulatory body in 2012.

In January 2020 all NPP actions were completed. Also almost all non NPP related actions are closed. Further updates on a limited number (three) of these actions will be provided through the process of the combined 8th and 9th Review Meeting of the Convention on Nuclear Safety (CNS). Further details are given below.

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. In 2021 one of these two actions was fully closed. The third action, which was included into the NAcP from the IAEA-Action plan, to make a decision about an EPREV mission, is open.

### **United Kingdom UK (closure report issued)**

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. UK published a closing report on implementation of the action plan in 2019.

## **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 2021, the National Action Plan was updated. At the end of 2021, more than 80% of the safety improvement measures planned in compliance with the updated National Action Plan have been implemented. The implemented measures include 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 task is ongoing and scheduled to be completed in 2023. Analysis of the strategy for possible corium confinement within the reactor pressure vessel are continued for the other reactor types.