European Nuclear Safety Regulators Group

ENSREG 1st TOPICAL PEER REVIEW

STATUS REPORT

November 2021

EXECUTIVE SUMMARY

Council Directive 2014/87/EURATOM amending Directive 2009/71/Euratom (the amended Nuclear Safety Directive) introduced a European system of Topical Peer Reviews (TPR) commencing in 2017 and at least every six years thereafter. The purpose is to provide a mechanism for EU Member States to examine topics of strategic importance to nuclear safety, to exchange experience and to identify opportunities to strengthen nuclear safety.

The first TPR took place between 2015 and 2019. According to the Terms of Reference and Technical Specification, the peer review focused on the Ageing Management Programmes (AMPs) at Nuclear Power Plants (NPPs) and Research Reactors (RRs) above 1 MWth. The review process consisted of the following phases: national self-assessments against the Technical Specification; questions and comments for the National Assessment Reports (NARs); a workshop with a goal to identify and discuss both generic and country-specific findings on Ageing Management Programmes; and lastly the preparation of a Topical Peer Review Report addressing the generic findings of the review process to provide input for National Action Plans (NAcPs) and ENSREG work. The sixteen European Union countries with Nuclear Power Plants and / or Research Reactors as well as Norway, Switzerland and Ukraine participated in the peer review.

The ENSREG Action Plan was published in November 2019, taking into account also the expectations in the European Union Council Conclusions in March 2019. The ENSREG Action Plan assists in assuring that the conclusions from the TPR are taken into account in improving nuclear safety across European nuclear facilities. It also assists in ensuring that the recommendations and suggestions from the TPR are addressed by national regulators and ENSREG in a consistent manner. The ENSREG Action Plan identified actions for Member States and ENSREG Working Group 1. In addition, there were actions related to EU level challenges. The current status of these actions is presented in this report.

All National Action Plans were prepared and published by the end of September 2019. All participating countries have prepared and published their updated NAcPs in 2021. A brief summary of the status in each country is presented in this report. Many actions have already been completed and the remaining ones appear to progress well, with most of them due to be finalised within a couple of years. The next deadline for updating the NAcPs is by the end of 2023.

The first TPR identified four European level generic challenges which were considered difficult to resolve for individual countries. ENSREG/WG1 was tasked to contact IAEA/IGALL (IAEA Extrabudgetary Programme on International Generic Ageing Lessons Learned), WENRA/RHWG (Western European Nuclear Regulators Association, Reactor Harmonisation Working Group) and NEA/CSNI/WGIAGE (Nuclear Energy Agency's Committee on the Safety of Nuclear Installations, Working Group on Integrity and Ageing of Components and

Structures) to discuss the general findings of the 1st TPR and to request support in working with the challenges. The current status of the related work in these international working groups is summarized in this report. IAEA/IGALL is covering many of the topics in their ongoing work programme. NEA/CSNI/WGIAGE is focusing on the topic of ageing management of concrete structures. WENRA/RHWG took into account lessons learnt from the first TPR in the revision of the Safety Reference Levels in 2020.

ENSREG/WG1 contacted also European Commission's Research and Innovation Directorate-General (RTD), in relation to the generic challenges, and to address the topics in EU Framework Programme for Research and Innovation. In addition, the Joint Research Centre raised awareness of the actions through its participation in NUGENIA-ENIQ.

One project, specifically related to addressing ageing of concrete structures, started under the Euratom Horizon 2020 programme. Other on-going research projects partially address the remaining EC actions. The Euratom Research and Training Programme for 2021-2025 allocates funding for nuclear safety, including "Follow-up actions on stress tests, Euratom-level peer reviews according to Article 8e(2) and (3) of the Nuclear Safety Directive ('Topical Peer Reviews')", though as yet no calls for proposals have been completed.

The planning of the second TPR has started. ENSREG/WG1 prepared a questionnaire to compile the feedback from the first TPR, analysed the responses and produced a "lessons learnt" report with suggestions to further improve the process. The findings and suggestions have been used when planning the second topical peer review.

The next status report of the first topical peer review will be prepared by the end of May 2024, on the basis of the updated NAcPs submitted by the end of 2023.

Contents

1 List of abbreviations:

AMP	Ageing Management Plan
ENSREG	European Nuclear Safety Regulators Group
IAEA	International Atomic Energy Agency
LTO	Long Term Operation
MWth	Megawatts thermal
NAcP	National Action Plan
NAR	National Assessment Report
NPP	Nuclear Power Plant
OAMP	Overall Ageing Management Plan
RHWG	Reactor Harmonisation Working Group of WENRA
RR	Research Reactor
SRL	Safety Reference Level
SSCs	Structure, Systems and Components
TLAA	Time Limited Ageing Analysis
TPR	Topical Peer Review
WENRA	Western European Nuclear Regulatory Association
WGIAGE	Working Group on Integrity and Ageing of Components and Structures

2 Introduction

In 2014, the European Union (EU) Council adopted directive 2014/87/EURATOM amending the 2009 Nuclear Safety Directive, to incorporate lessons learned following the accident at the Fukushima Daiichi nuclear power plant in 2011. Recognizing the importance of peer review in delivering continuous improvement to nuclear safety, the revised Nuclear Safety Directive introduced a European system of Topical Peer Review (TPR) commencing in 2017 and at least every six years thereafter. The purpose is to provide a mechanism for EU Member States to examine topics of strategic importance to nuclear safety, to exchange experience and to identify opportunities to strengthen nuclear safety. The process provides for participation, on a voluntary basis, of states neighbouring the EU which have nuclear power programmes.

The 30th Meeting of the European Nuclear Safety Regulators Group (ENSREG) in July 2015 identified ageing management of nuclear power plants as the topic for the first TPR. This selection was informed by a technical assessment performed by the Western European Nuclear Regulators Association (WENRA) in recognition of the age profile of the European nuclear reactor fleet and the safety significance of the topic. The Terms of Reference (ToR) and the Technical Specification (TS) of the TPR, as well as the Stakeholder Engagement Plan, were approved by ENSREG in January 2017 and published on the ENSREG website in February 2017.

In the first phase of the TPR, national self-assessments were conducted against the WENRA TS. The results of the self-assessments were documented in the National Assessment Reports (NARs), published at the end of 2017. The national reports were peer reviewed through a process organised and overseen by ENSREG, through the TPR Board.

The second phase started in January 2018 when the NARs were made available for questions and comments from stakeholders. As an indication of the commitment to the peer review and the importance of the selected topic, this phase resulted in more than 2300 questions and comments. Subsequently, in May 2018, ENSREG organized a one-week workshop to discuss the results of the self-assessments, the questions and comments on the NARs, as well as the replies to the questions, with a goal to identify and discuss both generic and country-specific findings on Ageing Management Programmes (AMPs).

In the third and final phase of the TPR, a Topical Peer Review Report and country-specific findings were compiled to provide input for national action plans (NAcPs) and the ENSREG Action Plan.

The TPR identified four challenges, which are common to many or all countries, and are areas where actions at the European level could help to increase available knowledge, drive

consistency or produce beneficial new techniques or technology to assist in specific aspects of ageing management.

The ENSREG Action Plan was published in November 2019 and it assists in assuring that the conclusions from the TPR are taken into account in improving nuclear safety across European nuclear facilities. It also assists in ensuring that the recommendations and suggestions from the TPR are addressed by national regulators and ENSREG in a consistent manner.

The Action Plan promotes the role of Europe in enhancing standards for worldwide nuclear safety through continuous improvement, showing a clear commitment to openness and transparency.

The TPR follow-up process has the following objectives:

- to ensure that the identified areas for improvement related to ageing management activities are addressed by national regulators;
- to develop actions for the EU level challenges;
- to improve the next TPR process.

The ENSREG Action Plan identified actions for Member States and ENSREG Working Group 1. In addition, there were actions related to EU level challenges. Those actions are presented in the following chapters (in italics) and the current status is shown after each action.

3 Member States' Actions

MS1. *Each national regulator will consider the results of the TPR as they are published in the ENSREG Topical Peer Review Report and country specific findings reports by the end of September 2019. Each national regulator will develop and make public its national action plan (NAcP) associated with lessons learned and TPR review recommendations and suggestions. Preparation of the NAcPs by end of September 2019 for the part related to Nuclear Power Plants and Research Reactors. For the other Nuclear Installations, to report by the end of 2020 (or already in September 2019 on a voluntary basis).*

All NAcPs related to nuclear power plants (NPPs) and research reactors (RRs) were prepared and published by the end of September 2019[1] . For the other nuclear installations not covered by the peer review, the TPR Board made the following recommendation in the ENSREG report:

[1] http://www.ensreg.eu/tpr-national-action-plans

"The Board recommends that countries explore the regulation and implementation of Ageing Management Programmes of other risk significant nuclear installations while developing and implementing National Action Plans to ensure they exist and are effective." The topic was discussed in the ENSREG plenary meeting in March 2019 and the following conclusion was recorded in the meeting minutes: "For the other Nuclear Installations, invite participating countries to report, on a voluntary basis, in 2020 (or already in September 2019)." Most of the NAcPs included also a separate brief section for the other nuclear installations.

MS2. *Each national regulator will provide an updated NAcP including a summary of the implementation status of NAcP by end of May 2021 that will be used when preparing an ENSREG status report.*

All participating countries have prepared and published their updated NAcP[2]. A brief summary of the status in each country is presented below. The original NAcPs describe the individual actions in detail.

Belgium

In September 2019 Belgium reported that for NPPs all actions from the self-assessment were closed and no country-specific findings were provided. The NAcP concentrated only on the evaluation of good practices attributed to other countries and the generic findings on electrical cables. Of the eight NPP-actions formulated, the update shows that all but one, which is pending review by FANC, are closed. Three actions are no longer followed, due to the final closure of the NPPs in 2025. One highlight can be mentioned, related to an improved inspection program of concrete structures that has been carried out and concluded that no severe defects were found. For RRs there are no country specific findings. For RRs thirteen actions were formulated based on the self-assessment. In the NAcP update report, four actions are reported as closed. Eight of the remaining nine actions are followed in the PSR2016 project and one in the PSR2036 project aimed at justifying continued operation of BR2 until 2036. As a highlight, it can be mentioned that the neutron measurement chains were renewed, all important cables are now contained in a database and no cables were found to be in an aggressive environment.

Bulgaria

The original NAcP included eight actions of which five have been now completed and three are still in progress. The regulatory body has further developed its inspection programme in the area of ageing management. The licensee has further developed the methodology for

[2] http://www.ensreg.eu/tpr-national-action-plans

scoping systems, structures and components (SSCs) for ageing management and included boric acid influence as a potential degradation mechanism upon contact with the outer surface of the reactor pressure vessel in the AMP. The licensee has also reconstructed some of the pipelines penetrating the concrete of the component cooling water system and performed further surveys for concealed pipework, based on which some sections have been replaced. The actions still in progress/planned include: 1) assessing residual lifetime of low voltage cables operated under normal environmental conditions (expected to be finalized by the end of 2021); 2) requalification of low voltage cables for accident conditions (since the current qualification is valid until 2029, the implementation plan is by the end of 2027); and 3) qualification of cables for extended beyond design basis accident (BDBA) conditions and throughout their expected life cycle (implementation by the end of 2028).

Czechia

In the original NAcP of the Czech Republic it was reported that all four actions identified in the self-assessment were closed by the time the NAcP was issued. Based on the country specific findings in the ENSREG report, the NAcP contained one additional action to be implemented with the deadline December 2021. This action is related to the implementation of requirements for identification of ageing mechanisms and appropriate corrective actions in the case of extended shutdown into the appropriate NPP AMP control documentation. In the updated NAcP, it was reported that this action is still in progress and it is expected to be finalized by the end of 2021.

Finland

The original NAcP included five actions. Three of these actions are related to further developing the overall ageing management programmes (OAMPs) and ageing management in prolonged construction projects and maintenance outages. These actions are still in progress and they are expected to be finalized by the end of 2021. Two other actions that are related to updating AMP for civil structures and electrical cables, have been finalized.

France

France has completed the implementation of all actions resulting from the follow-up of the first TPR. As a result, it issued in June 2021 its final report, updating its NAcP published in September 2019. The 2019 report contained six actions: four for the NPP fleet (58 operating power reactors plus the EPR under construction) and two for RRs (Cabri, which is operating and the Jules Horowitz reactor (RJH),under construction). The findings issued from the self-assessment and the peer review concerned the OAMPs (for both NPPs and RRs) and concealed pipework. All actions were implemented and the NAcP is therefore closed.

Germany

The original NAcP included two actions. For the first action, the nuclear licensing and supervisory regulatory bodies (federal and state) were to assess the need of putting German nuclear rules and regulations in more concrete terms in respect of extended shutdowns. Due to the timeline of the review process for German Nuclear Standards, the deadline for this action has changed to 2022. In the second action, for RRs, the systematic application of ageing management is to be improved in accordance with the graded approach. The RRs have begun to assess their OAMPs and the nuclear licensing and supervisory regulatory bodies are monitoring the process. However, the deadline for finishing the process has been postponed to 2022.

Hungary

The NAcP of Hungary contains four actions based on the country specific findings in the ENSREG report. In the updated NAcP, it was reported that two actions have already been implemented by the regulatory body according to the deadline. One of these actions relates to the extended shutdown regulation, and the other is for ensuring the adequate number of surveillance samples for new plants. The actions implemented by the licensee are still in progress and they are expected to be finalized by the end of 2022. One of these actions relates to component specific AMPs for concealed pipework and the other relates to the specific AMPs of inaccessible cables.

Italy

The Italian NAR for the TPR on Ageing Management provided an overview on the national regulatory framework applicable only to research reactors.

The findings for Italy concerned some areas for improvement regarding the OAMP of the two RRs and electric cables, reactor pressure vessel, concrete containment structure and pre-stressed concrete pressure vessel for TRIGA RC –I.

The NAcP of Italy (2019) contained some actions based on the country specific findings in the ENSREG report. The actual situation of the implementation of these actions is reported below:

- **TRIGA Mark II:** the licensee has performed all the activities, listed in the first road map in 2017, necessary to incorporate ageing into the integrated management system (IMS) that was in force. Currently, the licensee continues to monitor and improve the OAMP.

- **TRIGA RC–1**: The information on the implementation was updated in 2019 and 2021. For all activities, the planned completion has been postponed to 2022 due to the

pandemic situation. The implementation phase will start in 2023 and it will finish in 2024. The first inspection activities identified in the AMP for electrical cables, hydraulic circuit and container will start in 2022 to be continued 2023 – 2024), and the updated information will be included in the NAcP to be finalized in May 2024.

Poland

In the updated NAcP of Poland, it was reported that all three actions from the self-assessment were implemented in 2019 in the new AMP of the Maria Research Reactor. Based on the country specific findings in the ENSREG report, the NAcP contains four actions (three for concealed pipework, one for electrical cables) for which the implementation is either performed in a continuous manner or the implementation will depend on the result of AMP activities, so there is no definitive deadline for the actions. One further action, which is related to the use of external peer review services dedicated to ageing management or with elements of review dedicated to ageing management, is partially implemented. An Invitation to the IAEA regarding an OMARR mission was sent in 2021.

Romania

The original NAcP included 11 actions. Actions related to Cernavoda NPP included revisions to AMPs and guidelines, further developing the methodology for scoping SSCs for ageing management, defining a set of specific OAMP performance indicators, and implementing a proactive AMP for cables. Three of these actions are completed. For five actions, the deadline is at the end of 2021. The reactor building AMP programme is expected to be enhanced by the end of 2022. The regulatory body will also revise a regulation in order to include explicit provisions on ageing management during long construction periods or long shutdown of NPPs. The revision of the regulation is in progress and the target deadline is December 2021. Actions have also been taken for improving the overall AMP for the TRIGA research reactor in 2019.

Slovakia

The 2019 NAcP and its update reported on the implementation of all findings identified during the TPR process including those identified during the self-assessment. From the overall findings three findings were identified which needed further actions (shortcomings in SSC drawing documentation for the purpose of ageing management, update of the ageing management database and long construction periods or extended shutdown). Of these three findings, two are identical with the outcomes of the periodic safety reviews (PSR) performed at the NPPs (there is no research reactor in Slovakia). One action is complete (drawings) and the second one (database) is in progress with a deadline of 2023. The implementation of this action is subject to regular monitoring/inspection by the regulator (ÚJD SR) because of its link to the PSR. The third action (long construction periods or

extended shutdown) is in progress to be completed in 2021. ÚJD SR performed an inspection in 2021 with a focus on long construction periods (in relation to Mochovce 3&4 NPP) and extended shutdown to confirm the status of works.

The ÚJD SR safety guide on ageing management of NPPs was reviewed to take into account the newest outcomes of the International Generic Ageing Lessons Learned (IGALL) program of the IAEA and of the TPR on ageing.

Slovenia

In September 2019 Slovenia reported that all actions from the self-assessment were closed and that there were no country specific findings. Although not required, Slovenia also paid attention to the general challenges. From the Generic Findings nine actions were formulated (four for electrical cables, two for OAMP and one each for concealed pipework, RPV and concrete containment structure). According to the updated NAcP, five actions have been closed. One action has been finished in principle but is kept open, awaiting the final legislative steps. Three actions are still open and progressing and expected to be finalised by the end of 2022. Most actions relate to improvement of procedures, however one action that has generated a comprehensive inspection program should be highlighted: inspection of pipeline sections pertaining to the systems of essential service water and of storage of diesel fuel was carried out within penetrations in concrete walls during the outage in 2019. A guided wave ultrasonic testing method was used for this purpose. Analysis of the results showed that there were no degradations found that would require mitigation actions.

Spain

The original NAcP included 14 actions. All actions related to concealed piping are implemented. For electrical cables, there are two types of actions in the NAcP: methods for monitoring and directing all AMP activities and consideration of uncertainties in the initial environmental qualification (EQ). In relation to the first action, currently all Spanish NPPs have developed methods to collect cable ageing and performance data to support the AMP for cables. As for the second action, there is a common approach to all the plants through the project “Monitoring and assessment of the status of electrical cables in the Spanish NPPs”. The project started in 2020 and it consists of three phases, the first one is already finished and the phases two and three will be finished in the fourth quarter of 2024. For reactor pressure vessels, volumetric inspection for nickel base alloy penetrations are either complete or under preparation. The last inspections are planned for 2025. Non-destructive examinations in the base material of the beltline region are also in progress according to the NAcP schedule.

Sweden

The three Swedish NPP licensees have submitted a self-assessment of the current progress of the identified actions in the NAcP. In addition, one “Other Risk Significant Nuclear Installations” (The Swedish Central Interim Storage Facility for Spent Nuclear Fuel, Clab) also submitted an assessment of all generic findings from the TPR process. SSM considers that all licensees now have an OAMP that fulfils SSM requirements and international expectations. SSM found previously in the NAR that none of the Swedish licensees have been working with quality management of the overall OAMP in a systematic manner. SSM concludes that work is progressing in this area and finds it important for the licensees to continue this cooperation as well as participating in international fora in order to improve quality management. During the TPR workshop, one of the challenges identified was “Acceptance criteria for the degradation mechanisms”. SSM concludes from this review that this is also a challenge for Clab. Furthermore, SSM concludes that Clab needs to perform more frequent trending analysis, in order to prevent the structure from degradation related to ageing.

The Netherlands

The NAcP in September 2019 formulated ten (sub)actions for NPP Borssele (of which one was already completed) and two for the Research Reactor HFR. In addition, seven (sub)actions were formulated for the regulatory body ANVS. From nine remaining actions the NPP has completed five actions, four are still on-going. Two of the on-going actions were delayed one year from 2020 to 2021 due to the COVID-19 situation. The reason in both cases was the reduction of the activities during the annual refuelling. A highlight is that automated messages from the work management system are now being sent to relevant personnel whenever equipment becomes available to perform an opportunistic inspection. The HFR has completed one action, but the other (related to an IAEA mission) is postponed due to COVID-19. ANVS has completed four of seven actions. Three other actions are on-going, but delayed for one year; two of them due to COVID-19, both being future license updates once the PSR and related INSARR mission are accomplished.

Switzerland

The original NAcP included three actions. The annual reporting of the Swiss nuclear facilities regarding aging management is to be further harmonized and the requirements for the evaluation of national and international operating experience, as well as for the demonstration of the effectiveness of the aging management programme, are to be specified more precisely. The revised guideline ENSI-B02 has been issued in February 2021. The annual safety reports are to be adapted by the Swiss NPPs in accordance with the revised guideline. Also, guideline ENSI-B01 “Ageing Management” has to be checked whether the process to identify SSCs subject to ageing management (scoping process) is in line with the recommendations of the new IAEA Safety Guide SSG-48. The requirements on

ageing management for concealed pipework in the Swiss NPPs are to be explicitly specified in the next revision of this regulatory guideline. The current target for the guideline revision is the end of 2022.

Ukraine

The scope for the Ukrainian self-assessment was at operating NPPs (operated by Energoatom) and the Nuclear Research Reactor WWR-M (operated by the Nuclear Research Institute of the National Academy of Sciences of Ukraine).

The original NAcP included nine actions, seven for NPPs (consisting of 11 sub-actions), one for NRR (consisting of 2 sub-actions) and one for nuclear installations other than NPPs.

Four sub-actions are being conducted on a regular basis: appropriate research measures of concealed pipework are taken on a regular basis; up-to-date systems for remote NDI of RPV metal are implemented on a regular basis for all NPPs.

Four sub-actions are fully completed: two separate documents with the requirements for AM and LTO are developed and standard AMP was cancelled, provisions of the Integrated Program for surveillance specimens were improved, detailed requirements for consideration of 4N safety class components and structures were issued, cables ageing management programs were revised.

Four sub-actions will be completed by the end of 2021 / early 2022: the development of AMP for the RPV for each power unit is at the final stage, closed test-samples of the cylindrical part of the reactor vessel with a weld (for qualification of remote NDI of RPV metal systems) are under manufacturing, 4N safety class components and structures screening requirements methodology are at the final stage of development, AMP for concealed pipework is at the final stage of development.

Four sub-actions are scheduled to be completed in 2023-2024: NPP containment concrete constructions AM process is being improved; NRR standard AMP is being improved; obsolescence management analysis and measures development; and National Requirements for Ageing Management of Nuclear Installations (other than NPPs) is under development.

It should be noted that the number and the scope of planned measures have not been changed. The status and schedule for implementation of the measures have been specified.

United Kingdom

The scope for the UK's self-assessment was on operating power reactors (EDF-NG) and the two EPRs under construction (NNB). It was found that all had adequate AMPs appropriate to the stages in their lifecycles. However, a number of secondary but beneficial improvements

were identified for both licensees and programmes for improvement were developed and agreed.

Actions for reactors concerned OAMPs (4), Electrical Cables (1), Concealed Pipework (2) and Concrete containment structures and pre-stressed concrete pressure vessel (2).

In addition, the Office for Nuclear Regulation committed to two actions: to publish a Technical Assessment Guide (TAG) on OAMP; and publish a report on the review of Sellafield Limited ageing management programme.

Completion of these actions was delayed due to COVID and is expected to be completed by the end of 2021.

Overall, as of July 2021, five actions have been completed. Six actions are ongoing, with anticipated completion dates spanning August 2021 to December 2022.

MS3. *Each national regulator will provide an update on the implementation status of NAcP by the end of 2023.*

The next deadline for updating the NAcP is by the end of 2023.

4 ENSREG General Actions

E1. *ENSREG/WG1 will compile the feedback from the TPR Board and from ENSREG Members about the first TPR exercise and will draw some lessons for the next TPR, based on a questionnaire to be developed by October 2019, reporting them to ENSREG by end of May 2020.*

On the 38th meeting of ENSREG in March 2019 it was decided that WG1 should compile feedback about the first TPR exercise, via a questionnaire (one response per country), and report this to ENSREG. National contact points could also seek the feedback of national stakeholders that participated in the TPR. All countries participating in the TPR returned the completed questionnaires in January and February of 2020.

ENSREG/WG1 analysed the responses and produced a “lessons learnt” report with suggestions to further improve the process. The overall conclusion was that the first TPR process was adequate and the main goals were reached. The peer review enabled countries to review their AMPs, share information and experience, and provided an open and transparent framework for participating countries to develop appropriate follow-up measures to further enhance safety with more effective AMPs. Nevertheless, some areas for

improvement were also identified that should be considered when developing the future TPR process.

This report summarizes suggestions in four areas.

1- The suggestions related to early start of the planning process, defining the roles of different organizations and timeline with objectives and milestones, have already been considered since an overall process description has already been adopted. The nomination of the Board for the TPR II has already occurred much earlier than in TPR I, and the nomination of experts has been initiated. Also, the lessons learnt for developing more systematic criteria for the topic selection were considered.

2- There are several suggestions for further development of the Terms of Reference (ToR) and the Board should be more involved in the development of the ToR from the beginning. The scope of the installations considered in the TPR should be discussed with WENRA/RHWG to be in line with the Technical Specification. Most significant improvement needs in the ToR were related to the findings. There should be clear definitions and criteria for findings and a clear process to assign country-specific findings.

3- Concerning the peer review workshop, there is a suggestion to restructure the workshop format in a similar way to the one used in review meetings of the Convention on Nuclear Safety. Coordination of the plenary and technical sessions should be improved and enough time should be devoted for discussion in order to clearly justify findings. Video conference possibilities should be developed considering the lessons learnt during the COVID-19 pandemic. Country delegations should have the needed expertise including participants from the licensees or TSOs as appropriate.

4- The summary report and country specific reports should include technical justifications of the findings.

These findings and suggestions have now been used when planning the second topical peer review.

E2. *ENSREG/WG1 will draft a status report of implementation of the first TPR so that ENSREG can finalise it by end of 2021.*

This is the present status report. This report will be presented to ENSREG plenary in November 2021 for approval so that it can be published by the end of 2021.

E3. *ENSREG/WG1 will prepare summary report on the updated national action plans by end of May 2024.*

ENSREG/WG1 will prepare the next status report by the end of May 2024. If all participating countries are able to publish a closure report by the end of 2023, the next status report will be both the summary report and closure report. If not, further follow-up activities will be discussed in ENSREG to follow the closure of all actions.

5 ENSREG Special Actions on the EU level Challenges

5.1 Challenge on Overall Ageing Management Programmes (OAMPs)

The first TPR identified the following challenge related to effectiveness of the OAMP and use of performance indicators: Indicators are considered important for the evaluation of the effectiveness of the OAMPs but no unified approach is available. Further development of improved performance indicators or other appropriate tools would enable consistent evaluation of the effectiveness of the OAMPs among NPPs.

The following actions were identified related to this challenge:

EC1.1. *ENSREG/WG1 will contact IAEA/IGALL (IAEA Extrabudgetary Programme on International Generic Ageing Lessons Learned) to discuss the guidance on evaluation of effectiveness of OAMPs (including performance indicators) that is being developed in the IGALL programme. The timeframe will also be discussed.*

ENSREG/WG1 chair contacted IAEA/IGALL chair at the end of 2019 regarding the general findings of the 1st TPR. IGALL discussed the topics in its Steering Committee and submitted their views. The evaluation of effectiveness of OAMPs was already partially addressed in IGALL Phase 4 (2018-2019). New sections on 'Plant Level AMP' and 'Evaluation of Effectiveness of Plant Level AMP and Individual AMPs' have been incorporated into a draft of IGALL Safety Report Rev.2. Efforts will continue in the IGALL Phase 5 (2020-2021) within IGALL Working Groups (WGs) 1, 2, 3 and 5.

The following results have been completed (status August 2021):

- The information on the OAMP, information was collected in IGALL Working Groups 1-3 for proven practices followed in various NPPs. IAEA Member States were requested to describe their practices. A description of the proven practices related to Plant Level AMP is contained in the forthcoming Revision 2 of the Safety Reports Series 82, to be published in 2023. Nevertheless, upon approval by the IGALL Steering Committee, expected in December 2021, a working version will be provided for the IGALL members.

- The same process was followed for the evaluation of effectiveness of the plant level and individual AMPs. The IAEA Member States were requested to describe their proven practices in terms of evaluation and indicators used to measure of effectiveness of AMPs. A new Section 5 "Evaluation of effectiveness of plant level AMP and individual AMPs" and two new appendices (Appendix VI Examples of performance indicators for plant level AMP, Appendix VII Examples of performance indicators for individual AMPs) were prepared for the Revision 2 of Safety Reports Series 82. The basic concept of evaluations of the effectiveness considers that while there are inputs to improve the AMPs on both individual and plant levels with relatively short periodicity, a natural cycle for improving the set of AMPs is rather longer, i.e. a period of 5-10 years due to the features of typical ageing phenomena. To distinguish, between these different effects, the Report addresses the evaluations in the short term and in the long term in separate subsections.

EC1.2. *ENSREG/WG1 will ask WENRA to discuss the topic in the frame of Reference Levels Review and to consider developing guidance on the use of performance indicators. The timeframe will also be discussed.*

ENSREG/WG1 chair contacted WENRA and WENRA/RHWG (Reactor Harmonisation Working Group) chairs in the end of 2019 regarding the general findings of the 1st TPR and whether WENRA/RHWG could initiate any tasks related to them. WENRA/RHWG discussed the topics in its meeting in 2020 and came to the following conclusion: "RHWG considers that it is not within its remit to include the use of performance indicators in its RLs or guidance at present. It was noted that it is the responsibility of the licensee to define performance indicators. In addition, IAEA (IGALL WG 5) is currently undertaking work in this area which is to be completed in 2021." ENSREG/WG1 and WENRA/RHWG will keep in touch on that matter as new findings may lead to further activities. However, the results of TPR I were taken into account in the revision of the WENRA Safety Reference Level for Existing Reactors 2020. Issue I (Ageing Management)[3] has been revised and now includes important aspects from the findings of TPR I.

As a conclusion for the first challenge, it can be noted that IAEA/IGALL is the organisation which is further developing the use of performance indicators. ENSREG/WG1 will follow-up the progress of this work in the next TPR status report.

[3] https://www.wenra.eu/sites/default/files/publications/wenra_safety_reference_level_for_existing_reactors_2020.pdf.

5.2 Challenge on Concealed pipework

TPR identified the following challenge related to concealed pipework: Non-invasive inspection methods for detection of local corrosion, suitable for use on long lengths or complex geometries of concealed piping, are not well established. Research and development of such methods would enhance the tools available for demonstrating the integrity of concealed pipework and increase the overall safety of nuclear installations.

The following actions were identified related to this challenge:

EC2.1. *ENSREG/WG1 will contact IAEA/IGALL to discuss the proven practices collected in the IGALL programme related to ageing management of concealed pipework and to propose further tasks in the next phase of the IGALL programme, as appropriate. The timeframe will also be discussed.*

Regarding the concealed pipework, the current IGALL AMPs and TLAAs (Time-limited Ageing Analysis) will be reviewed by IGALL WG1, to incorporate any available proven practice in the IAEA Member States. No research and development will be conducted by the IAEA in this matter.

In relation to AMPs relevant for concealed pipework, IGALL WG1 in Phase 5 performed the following tasks:

- Identification of IGALL AMPs/TLAAs that have a potential link to inspection techniques that can be applied to detect corrosion of concealed piping. Review of these AMPs/TLAAs showed that AMP125 “Buried and Underground Piping and Tanks” already contains a comprehensive section devoted to inspection techniques and would be the most appropriate AMP to include any additional information regarding novel inspection techniques for concealed piping.

- The National Assessment Reports within the ENSREG TPR on Ageing Management were reviewed to identify novel inspection techniques for concealed piping. Bulgaria, Czech Republic, Slovenia and Sweden were asked to provide additional information on the novel inspection techniques, to be included in AMP125.

- IAEA Member States were also asked to submit any information regarding proven practices for non-invasive inspection methods for detection of local corrosion, suitable for use on long lengths or complex geometries of concealed piping.

- The Electric Power Research Institute (EPRI) was asked to provide a list of EPRI documents developed over the last 15 years on the advanced inspection techniques for concealed piping.

All relevant information gathered under these tasks has been integrated into AMP125 “Buried and Underground Piping and Tanks”.

EC2.2. *ENSREG will recommend the EC to promote research on the application of NDT techniques to identify defects in long lengths of concealed pipework to address the topic in EU Framework Programme for Research and Innovation.*

Through its involvement in NUGENIA Technical area 8 – European Network for Inspection and Qualification (ENIQ), JRC encouraged the other members to consider the possibility of a Euratom-funded R&D project. To date this possibility has not been taken up.

ENSREG/WG1 will follow-up the progress of these actions in the next TPR status report.

5.3 Challenge on Reactor Pressure Vessel

TPR identified the following challenge related to reactor pressure vessels: NDE techniques are continuously developing and improving and it is a challenge for licensees to know the current state of the art in qualified RPV inspection techniques.

The following actions were identified related to this challenge:

EC3.1. *ENSREG/WG1 will contact IAEA/IGALL to request to extend collection of proven practices within the next phases of the IGALL programme concerning state of the art new techniques and technologies for NDE. The timeframe will also be discussed.*

Regarding the third challenge, IAEA/IGALL response was: “This task is beyond the IGALL programme scope, so no action will be taken by the IGALL programme in this regard.”

EC3.2. *ENSREG will recommend for EC to establish and maintain an up to date European catalogue of state of the art new techniques and technologies for Non Destructive Examination (NDE) of reactor pressure vessels in EU Framework Programme for Research and Innovation.*

JRC raised the recommendation in the context of its participation in ENIQ. The consensus was that there were currently no challenges in this area. It was felt that existing requirements were sufficient at the present time e.g. ASME BPVC Section XI and the French RSE-M code contain clear rules and requirements for ISI of RPVs and their qualification.

Nevertheless, the Euratom Horizon 2020 programme is addressing factors influencing the integrity of RPVs during the long-term operation of NPPs through various projects, namely: the STRUMAT-LTO project which aims to address knowledge gaps in RPV embrittlement; the

APAL project, which is developing RPV integrity assessment for pressurised thermal shock; the ENTENTE project, which aims to design a European database for radiation embrittlement experimental and modelling data; the NOMAD project, with the goal to develop an NDE tool for the characterisation of the embrittlement in RPVs of operational reactors. Finally, the SOTERIA project has looked at the impact of neutron irradiation on RPV and internal steels.

As a conclusion for the third challenge, it can be noted the EU Framework Programme for Research and Innovation may potentially be the best way forward. ENSREG/WG1 will follow-up the progress of this work in the next TPR status report.

5.4 Challenge on Concrete Containment Structure

TPR identified the following challenge related to concrete structures: It is difficult to define objective and comprehensive acceptance criteria for ageing management of concrete structures. The development of such criteria for a number of degradation mechanisms would improve the effectiveness of the AMPs.

EC4.1. *ENSREG/WG1 will contact NEA/CSNI/WGIAGE to discuss their ongoing activities and whether this topic is already addressed or should be addressed in their work. The timeframe will also be discussed.*

ENSREG/WG1 chair contacted NEA/CSNI secretariat and NEA/CSNI/WGIAGE Concrete Subgroup chair in the end of 2019 regarding the general findings of the 1st TPR and to ask support in working with the challenges. Since the Covid-19 pandemic postponed the WGIAGE meetings, WGIAGE Concrete Subgroup discussed the topic only in its meeting in spring 2021 and submitted their views how WGIAGE is covering the identified challenge in its working program. Regarding the fourth TPR challenge, their response was: “WGIAGE Concrete subgroup has identified this challenge in the latest Medium-term strategy, which has been published in November 2015 (Containment / confinement required to be studied further, especially from ageing management and LTO point of view including concrete pathologies). Concrete pathologies have been studied at first in general level, continuing towards practical applications. Conclusions and recommendations for ageing management are reported in “Final Report of Assessment of Structures subjected to Concrete pathologies (ASCET) phase 1” and in “Phase II of the Assessment of Structures Subjected to Concrete Pathologies (ASCET): Final Report”. WGIAGE’s Concrete sub-group continues this work. New CSNI planned activities related to the challenge are starting: “Ageing management of typical liner structures of containments and spent fuel water pools” and “Shear capacity of typical concrete elements which are critical in nuclear facilities”. The timeframe for both activities is

two years. All studies within the Concrete sub-group are beyond concrete containment including also other important facilities in Nuclear Power Plants."

EC4.2. *ENSREG/WG1 will contact IAEA to initiate a review of acceptance criteria in the IGALL Ageing Management Programmes in the next phase of the IGALL programme. The timeframe will also be discussed.*

Regarding the fourth challenge, IAEA/IGALL response was: "Current IGALL AMPs and TLAAs will be reviewed by IGALL WG3. If there is any available proven practice in Member States, it will be incorporated into IGALL AMPs and TLAAs in IGALL Phase 5 (2020-2021)." The issue was addressed during IGALL phase 5 as follows:

- IGALL WG3 discussed the development of acceptance criteria for concrete structures for inclusion in new AMP318 (previously part of AMP306) which deals with the monitoring of concrete structures. It was concluded that several Member States and organizations have already developed the criteria for evaluation of concrete structures. Accordingly, the American Concrete Institute ACI Standard 349.3R-18 criteria was elaborated in AMP318 as follows: ACI 349.3R-18 is a widely used report that provides comprehensive three-level acceptance criteria for the evaluation of existing nuclear safety-related concrete structures. Its focus is on commonly occurring deterioration conditions, illustrated in ACI Standard 201.1R-08, for example chemical attack, pop outs, voids, scaling and passive cracks. The three-level evaluation criteria are provided in terms of acceptance without further evaluation, acceptance after review (i.e. additional inspection and testing to identify cause, activity, and effect of deterioration), and further evaluations required (i.e. more extensive application of testing and analytical methods to assess current capabilities and develop a remedial measure program, when required).

- References have been updated and additional operating experience has been incorporated into AMP318. The ageing management review table was also reviewed and original lines containing AMP306 have been corrected to include references to AMPs 318 and 319. The Steering Committee approved both AMPs in December 2021.

- Comparing with concrete structures addressed in AMP306, the scope of AMP318 has been expanded to include secondary containment and aircraft protection building. As additional action for ageing management of concrete structures, a new TLAA305 on irradiation damage on concrete was developed by IGALL WG3 and then approved by IGALL Steering Committee in December 2021.

EC4.3. *ENSEG/WG1 will ask WENRA to discuss the topic in the frame of Reference Levels Review and consider to develop a guidance on using of acceptance criteria for ageing management of concrete structures.*

Regarding the fourth challenge, WENRA/RHWG response was: “RHWG considers that it is not within its remit to include acceptance criteria for ageing management of concrete structures in its Safety Reference Levels (SRLs) or guidance at present because the topic is too specific and technical. RHWG noted that SRL I 2.2 addresses acceptance criteria and SRL I 2.6 addresses effectiveness of AMPs (SRL 2020).” Lessons learnt from the first TPR were taken into account in the revision of the SRL 2020. ENSREG/WG1 and WENRA/RHWG will keep in touch on that matter as new findings may lead to further activities.

EC4.4. *ENSREG will recommend for EC to address the topic of ageing of concrete structures in EU Framework Programme for Research and Innovation.*

The issue is currently being addressed through the Horizon 2020 ACES project. The purpose of ACES is to advance the assessment of safety performance of safety-critical concrete infrastructure by addressing remaining scientific and technology gaps for the safe and LTO of NPPs. This collaborative project aims to clarify, enhance and unify methods of structural integrity assessment in support of LTO.

The project scope of work focuses mainly on safety critical reinforced and pre-stressed concrete structures. ACES is aimed at an experimental proof of concepts, and validates the developed methodologies at both a laboratory scale and a quasi-full scale level (mock-ups).

ACES aims at having a significant impact on the safety of operational Generation II and III NPPs, and impact the design of next-generation plants. ACES will improve the understanding of ageing and deterioration of concrete, and will demonstrate and quantify inherent safety margins introduced by the conservative approaches used during design and defined by codes and standards employed throughout the life of the plant. The outcomes from ACES will therefore support the LTO of NPPs.

As a conclusion for the fourth challenge, it can be noted that NEA/CSNI/WGIAGE’s Concrete Subgroup and IAEA/IGALL are the organisations that are mostly involved in developing further the ageing management acceptance criteria for concrete structures. ENSREG/WG1 will follow-up the progress of this work as well as the related activities in EU Framework Programme for Research and Innovation in the next TPR status report.