ROMANIA

National Action Plan based on the first EU Topical Peer Review on Ageing Management for Nuclear Installations

September 2019

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1. 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 Reviews (TPR) commencing in 2017 and 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 peer review focused on the Ageing Management Programmes (AMPs) at Nuclear Power Plants (NPPs) and Research Reactors (RRs) above 1 MWth. In addition to reviewing the programmatic part of ageing management, the peer review process examined the application of the AMPs to the selected systems, structures and components (SSCs) in four thematic areas, namely: electrical cables, concealed piping, reactor pressure vessels, or equivalent structures, and concrete containment structures.

The main objective of the first Topical Peer Review was to examine how well Ageing Management Programmes in participating countries meet international requirements on ageing management (in particular WENRA Safety Reference Levels – (SRLs) and the IAEA Safety Standards). All participating countries made a self-assessment and reported results in their National Assessment Reports. Most countries identified themselves a number of areas for improvement, good practices and challenges. In the course of the Topical Peer Review, national results have been evaluated through the peer review process, complementing the national assessments.

In accordance with the provisions of the Nuclear Safety Directive, the National Action Plans established by the Member States should address the results of the self-assessment and respond to the country specific findings allocated to them for reaching the Topical Peer Review expected level of performance. Furthermore, the countries are encouraged to explore all generic findings of this peer review and to study their applicability to improve the regulation and implementation of Ageing Management Programmes at each Nuclear Power Plant and Research Reactor.

The present document outlines the National Action Plan (NAcP) of Romania, prepared in accordance with the requirements of the TPR process, set out in the standard format (template) that was provided by ENSREG. The document is intended to enable monitoring of the progress in the implementation of the actions emerging from the first TPR.

The action plan addresses improvements of the regulatory framework and of the ageing management programmes for Cernavoda NPP and for the TRIGA Research Reactor.

2. FINDINGS RESULTING FROM THE SELF-ASSESSMENT

2.1 Overall Ageing Management Programmes (OAMPs)

Background

Cernavoda NPP, the only nuclear power plant in Romania, has two units in operation, pressurized heavy water reactors of CANDU 6 design (CANadian Deuterium Uranium), having a design gross output of 706.5 MWe each. Unit 1 and Unit 2 started commercial operation on the 2nd of December 1996 and on the 1st of November 2007, respectively.

Cernavoda NPP adopted a new policy to ensure the reliability of critical Systems, Structures, Components (SSCs) at competitive costs by developing technical programs (common for both units) according to INPO AP-913 Equipment Reliability philosophy.

To attain this objective, a new process was developed - "Maintaining Equipment Reliability Process" (MERP), as the most important pillar of the overall Aging Management strategy for Critical SSCs.

The self-assessment of Cernavoda NPP overall AMP, documented in the National Assessment Report for the EU Topical Peer Review on Ageing Management for Nuclear Installations, concluded that MERP philosophy is comprehensive, so that no significant changes need to be added to the current organization, content or structure of the overall AMP based on the new regulation, NSN-17, issued by CNCAN in 2016. However, Cernavoda NPP identified 3 opportunities for improvement, to align completely to the NSN-17 requirements, as follows:

1. Revision of Equipment Reliability Process and PLiM procedures to integrate all the activities at interface (such as: Chemical Control, Margin Management, Proactive Obsolescence Management) to better sustain the international approach for an integrated AM Program;
2. Documenting the strategies to keep alignment of the Periodic Inspection Program with the recent Code standard editions**;**
3. Performing an in-house analysis of the actual PM/PLiM programs conformity with IAEA best practice model, verifying the 9 generic attributes of an effective AMP against IGALL documents. It was considered to be a good exercise to identify eventual gaps and to revise the current CNPP Programs, prior to the next PSR evaluation, which started in 2019 for U2 and will start in 2020 for U1.

Additional improvements may be identified and implemented in the context of the following assessments:

- 1st Periodic Safety Review of Cernavoda NPP U2, started in 2019;
- IAEA Peer Review: Pre-Safety Aspects of Long Term Operation (SALTO), scheduled for 11-19.02.2020 at Cernavoda NPP U1;
- 2nd Periodic Safety Review of Cernavoda NPP U1, scheduled for 2020;

which could change some of the current TPR findings, proposing an enhancement of a much more specific manner than the current measures.

2.1.1.1. Finding n°1 from the self-assessment

Area for improvement: *Revision of Cernavoda NPP procedures for Ageing Management to align them with the Romanian Regulation NSN-17 and the latest international approach in Ageing Management, as defined in WENRA Safety Reference Levels, IAEA Guidelines SSG-48, and SRS 82 IGALL AMPs best practice model.*

The actions to address this area for improvement were included in the Cernavoda NPP action plan U1/U2-PA-16-0040, Section 1, issued for complete alignment to the requirements of the national regulation NSN-17 for Ageing Management. The first step of the plan was to update Cernavoda NPP procedures at programmatic level, in order to ensure compliance with the latest international approach in Ageing Management, striving for systematic identification of SSCs, early implementation of AMPs and increased effectiveness of the AMPs, as follows:

- emphasizing in the main process procedure (RD-01364-T010 MERP) the cross-connection between the activities performed all over the NPP for AM control, in accordance with main Equipment Reliability process and other different processes, such as Licensing, Maintenance, Planning, Design Configuration Control, Chemistry Control, Operation, or Nuclear Supply Chain;
- documenting the integrated Overall Ageing Management Program (OAMP) and the cross connections with all the processes and programmes implemented up to date, to support and assess its effectiveness in IR-98100-009;
- requirement to align Cernavoda AMPs to the 9 generic attributes of an effective AMP, as per IGALL best practice model was included in the specific Station Procedure: SI-01365-P093 Plant Life Management (PLiM);
- instruction for trending of key performance parameters, identification of acceptance criteria and criteria for PLiM programs revision, based on implementation results and trending, alignment to recent Code Standard editions, effectiveness assessment through Life/Condition Assessments or following Periodic Safety Review (IDP-TU-068 Elaboration of PLiM Program Manuals).

2.1.1.2. Country position and action on finding n°1

All the revisions of the above mentioned documents have been completed and are in effect at present, therefore **Romania considers finding n°1 closed**.

2.1.2.1. Finding n°2 from the self-assessment

Area for improvement: *Documenting the strategies to keep alignment of Periodic Inspection Program with the recent Code Standard editions.*

As nuclear installations age, based on the experience accumulated from operation, new inspection requirements might be required, so that, invariably, new, updated mandatory inspection requirements are imposed by the Regulatory Authorities on the licensees. In Romania, the requirement to keep alignment to the recent editions of the applicable Codes and Standards is embedded in the Cernavoda NPP operating licenses since the beginning.

Over the time, a regulatory guide (GSN-01) was issued in 2015, establishing the list of codes, standards and national prescriptions to be respected by the NPP in all stages of plant operation, including in the implementation of the ageing management program.

Later, in 2016, a specific regulation on Ageing Management for nuclear installations, NSN-17 was issued, requiring in Art. 15, that the licensees maintain a close contact with international operational experience, new findings in R&D and to revise the AMPs with relevant ageing information and new inspection methodologies, in accordance with IAEA safety standards SSG 48, SRS 82 and WENRA SRLs latest requirements (generic attribute #8).

The international standards and guides used for the ageing management programme of Cernavoda NPP mainly consist of the mandatory codes and standard requirements (e.g. ASME, CSA, ASTM, ANSI, IEEE, IEC, ISO) and the best practice guidelines recommended by EPRI, WANO, INPO, COG, etc.

The requirement is included in the main process procedure (RD-01364-T010-MERP), in the specific procedure for Ageing Management (SI-01365-P093 Plant Life Management), in the detailed procedure for Periodic Inspection (SI-01365-T057 Periodic Inspection Program). The assessment of the external operating experience applicability, benchmarking and new R&D technologies is performed and reported periodically through the Program Health Monitoring Reports, through the mandatory performance indicators.

As for the awareness of the Code & Standards changing requirements, compliance with the requirement is ensured through participation in the appropriate COG Peer Group /Working Group /Task Team, created in the Information Exchange section, as part of the base program membership, to which Cernavoda NPP is affiliated since 1991. Cernavoda NPP has nominated representatives who attend or are informed about the topics discussed in the periodic Meetings (for instance: NDE Peer Group or Risk Informed In-service Inspection Task Team).

Moreover, at plant level, in the context of the numerous regulations issued in the recent years, Cernavoda NPP, as operating license holder, has developed the following process to ensure alignment and timely compliance with any new legal requirements, resulted both from the national authorities, but also from the international organizations (WANO, EPRI, COG, IAEA, ISO, etc.):

- monitor continuously the new legislation published officially via a software application and verify quarterly the sites of external organizations for any new edition of Codes, Standards and guidelines issued;
- document the differences in a comprehensive gap analysis, between the current Cernavoda NPP Programs, processes or procedures and the new standard edition, and identify the gaps and the necessary actions to address these gaps;
- agree with the Regulatory Authorities the implementation strategy or an action plan;
- the utility approves and implements the recommendations and the Regulatory Body perform reviews and inspections to assess the adherence to the compliance plan and the compliance status.

The above requirements are documented in the interface procedure PSP-Q007-010, issued in 2017 under the governance of the overall management process for the documents and records update - RD-01364-Q007.

2.1.2.2. Country position and action on finding n°2

Cernavoda NPP has a comprehensive process to maintain the alignment with the latest editions of codes, standards and regulations, which ensure awareness of and compliance with any new requirements. The process requires, through the specific procedures (PSP-Q007-010), to perform a conformity gap analysis and take all the necessary actions to ensure timely compliance. The progress in action plan implementation is monitored until the end, through self-assessments, audits from QA Department, CNCAN reviews and inspections and international Peer Review missions. **Romania considers finding n°2 closed**.

2.1.3.1. Finding n°3 from the self-assessment

Area for improvement: *Assess the compliance of Cernavoda NPP current Ageing Management programme with IAEA best practice model, verifying the 9 generic attributes of an effective AMP against IGALL documents.*

The results of the self–assessment of Cernavoda NPP technical AMP versus IGALL AMPs nine generic attributes of an efficient program and international operating experience, performed in 2017-2018, revealed that:

new AMPs need documentation, such as the Calandria vessel PLiM Program, to cover AMP 141 “CANDU/PHWR Reactor Assembly” and AMP 119 “One-Time Inspection of Calandria Vessel”.

a new program Manual was issued for the Calandria vessel, containing the inspections required to be performed with the next opportunity of drainage, which is scheduled during the Refurbishment Outage.

some PLiM Program Manuals require minor revision, to include more components into the scope (such as Digital Control Computers where relays, condensers and fuses were added and Expansion Joints where specific EJs where added, following the Fukushima Stress Test results), or Cables, where an assessment of testing relevance was detailed and the inspection strategy was adapted to this assessment, as recommended by EPRI/NRC/ IGALL AMPs latest guidance.

other AMPs require enhancement of program technical basis, such as: Reactor Building, Supports & Snubbers, Buried (Concealed) Piping, scheduled to be completed in the period 2019-2021.

The self-assessment included also the PM programmes developed at Cernavoda NPP for active components, for which the revision of the technical basis document is monitored through a separate action plan: U0/1/2-PA-17-0058, section 2. At present, the action is in progress as scheduled, to be finalized until January 2021.

As such, the process of compliance verification and alignment to the latest international OPEX (EPRI, IGALL) is continuous and actions are in place for RSE/RCE (responsible system engineers / responsible component engineers) to assess the applicability of the latest guidelines for Ageing Management, in accordance with EPRI Report 3002013053 - ”2018 Update to EPRI Product Mapping to IAEA IGALL Aging Management Program Categories” (published in November 2018). The results are monitored in the periodic SHMR/CHMR meetings.

2.1.3.2. Country position and action on finding n°3

Alignment of Cernavoda NPP programmes documents with the international best model practice in Ageing Management is a continuous process, considered to be progressing well towards completion, as follows:

a) at programmatic level, the procedural basis was updated, in line with SSG 48, SRS 82 and WENRA SRLs requirements through the revision of the AMP procedures according to NSN-17 Norm for Ageing Management for nuclear Installations (U1/U2-PA-16-0040, section 1- complete);

b) the self-assessment for the compliance of Cernavoda NPP current Ageing Management programs with IAEA best practice model IGALL (U1/U2-PA-16-0040, section 2-complete);

c) ensure a comprehensive process to maintain alignment of Cernavoda NPP Programmes with any new legal requirements, resulted from the national authorities, but also to best practice guidance from international organizations (WANO, EPRI, COG, IAEA, ISO, etc.) – complete;

d) the revision of Cernavoda AMPs technical basis (Program Manuals) is in progress, and is scheduled to be finalized until January 2021 (**see action 3, section 7**);

e) the process of compliance verification and alignment to the latest international OPEX (EPRI, IGALL) is continuous (**see action 2, section 7**).

2.2 Electrical cables

2.2.1 Finding n°1 from the self-assessment

Area for improvement: *Implement a proactive AMP for cables. Complete external services for advanced aging testing methodologies will be contracted to obtain Life Assessment reports and recommendations for Cable program enhancements.*

The current in-service monitoring activities provide physical status monitoring, based on the as-found files of visual inspections (mainly performed during planned outages), as well as monitoring of the values and evolution of the operating parameters obtained in the electrical tests.

Cable Health Status Reports provide all the necessary technical information for an efficient management for safe operation and maintenance of selected cables. These report sections contain the analysis based on the monitoring of the functional parameters, the inspections results, the operating experience information and analysis and the evolution of the component condition. The actions needed to correct indicators that have a worsening trend are mentioned in a separate section of the Health Report. Reducing the influence of these contributors will be achieved by identifying them in the inspections and removing the causes.

No significant age-related issues have been encountered so far, as the design and environmental qualification of the safety related electrical cables has large margins when compared to the actual operating conditions. Nevertheless, the cables included in the PLiM program need continuous monitoring of their state and condition, so that measures can be taken before defect occurrence leading to unavailability of the serviced equipment, with a major impact in the operation of the plant.

A global Life Assessment (LA) study for the electrical cables is being purchased for the overall assessment of the effectiveness of the AMP related to electrical cables. According to the schedule the contract will be available by 2021 and will also include the recommended actions for cables ageing management and long term reliability.

2.2.2 Country position and action on finding n°1

Complete external services for advanced ageing testing methodologies will be contracted to obtain Life Assessment reports and recommendations for Cable program enhancements, as a prerequisite needed for LTO (**see action 8, in section 7**). CNCAN will monitor the implementation of this action.

2.3 Concealed pipework

Based on the experience up to date, the self-assessment of the Cernavoda NPP for the current AM program developed for Buried Pipe Program (Concealed Pipework), concluded that the program:

- is comprehensive and in line with the international good practice documents and guidance available on this topic (issued by EPRI, COG, INPO, NEI, ASME, etc);
- is effective in preventing unexpected age-related degradations in safety-related and non-safety related concealed piping; no significant issues have been identified up to present;
- is a living program, that contains direct actions for the most sensitive and high risk system piping and other indirect inspections and condition assessment of the concealed pipes from Unit 1 and Unit 2 identified with a lower risk from the risk-ranking selection.

A long-term Buried Piping Asset Management Plan (BP AMP) is currently under development at Cernavoda NPP and will address the following areas:

- the concealed piping condition and the ageing mechanisms that have acted over time on plant concealed piping;
- the required repairs or replacement activities for the next 10 years;
- possible changes recommended for the current BP program implemented in the plant, based on the condition assessment results, external OPEX, or Peer Review recommendations (areas for improvements or challenges).

There have been no actions for improvement or challenges identified from the TPR self-assessment in this area.

CNCAN will continue to monitor the AM program developed by the licensee for Buried Pipe Program (Concealed Pipework) and any changes / improvements to this program.

2.4 Reactor pressure vessel or Calandria/Pressure Tubes

All monitoring guidelines implemented in the Cernavoda NPP Fuel Channels Program and the long term strategy follows the development of AMP, in order to align to an accurate assessment of Fuel Channels condition, as well as future issues that can be developed. The process is an iterative one, involving regular updates to both the Calandria Vessel and the Fuel Channel AMPs, in order to implement the latest development in the industry, as well as research and development through national research institutes, COG and other entities.

To sustain the approach outlined above, the following documents were prepared and issued by Cernavoda NPP in the period 2018- 2019:

- A new AMP for Calandria vessel and its internals (IR-32100-001) was issued, according to the IAEA guides IGALL AMP 141 “CANDU/PHWR Reactor Assembly” and AMP 119 “One-time inspection of Calandria vessel” to assess and mitigate Calandria ARDMs evolution (e.g. chemistry control of D_2O moderator, H_2O from End Shield Cooling and moderator cover gas, welds inspection, calandria tubes fretting with LISS nozzles due to FC sag). The document incorporates also the OPEX data gathered from COG Joint Project 4271 “Calandria Fitness For Life Extension Guidelines” (2013), corroborated with recent Calandria Tube - LISS nozzles interspace measurements (performed in 2016); this action is now completed.

- The Safety Case for re-joining COG R&D subprogrammes FC and CM&C that were temporary suspended in 2016. Re-joining these programs is scheduled starting from 2020, after the publication of the specific regulation for Ageing Management, NSN-17, requiring the owners of nuclear installations to maintain a close contact with R&D novelties and knowledge; this action is now completed**.**

There have been no actions for improvement or challenges identified from the TPR self-assessment in this area.

CNCAN will continue to monitor the AM program developed by the licensee for Calandria / Pressure Tubes and any changes / improvements to this program.

2.5 Concrete containment structure and pre-stressed concrete pressure vessel

2.5.1 Finding n°1 from the self-assessment

Area for improvement: *Based on the recommendations of the Life Assessment studies, the licensee has elaborated an action plan for reinforcing and alignment of the actual RB PLiM programmes for U1&U2 to the latest international guides.*

Based on the recommendations from the Life Assessment (LA) studies for Cernavoda NPP Units 1 and 2, action plans have been issued in 2019 to implement a series of enhancement actions in the next years (2019-2021), to preserve and ensure the health of the Reactor Buildings.

The plans cover all the recommendations in the LA studies. Some of the most relevant improvements areas are as follows:

a) Enhancement of Program documentation (e.g. Revision of RB Program Manual and repair procedures);
b) Enhancement of Deformation Measurement System, in 2 main steps:
    - Refurbishment of the Embedded Strain Gauges System;
    - Assessment of the necessity of an additional Deformation Measurement System.
c) Improvement of leak-tightness of the Reactor Building containment structure, by means of:
    - Revision of the Program Manual to enhance PM program with RB repair activities between two consecutive RBLRTs (completed);
    - Implementation of the action plan that includes the recommendations from Cernavoda Unit 2 Reactor Building Leak Rate Test, performed in 2017. The actions refer to the improvement of the RB U1 &U2 inspection procedures, repairs procedures and the identification of non-destructive testing methods with proven efficiency in nuclear industry (completed).

2.5.2 Country position and action on finding n°1

The action plans described above address LA recommendations for Cernavoda NPP Units 1 and 2 Reactor Building Concrete Structures (**action 9, in section 7**). CNCAN has reviewed the LA studies and the action plans, have found them adequate and is monitoring their implementation.

3. Country specific findings resulting from the TPR

3.1 Overall Ageing Management Programmes (OAMPs)

3.1.1.1 Finding n°1: Methodology for scoping the SSC subject to ageing management

TPR expected level of performance / Area for improvement: *The regulatory framework in several countries requires the application of ageing management processes to both active and passive SSCs in accordance with WENRA SRL and IAEA Safety Standards. In some countries, ageing management is applied mostly to passive SSCs, whereas ageing of active SSCs is managed via maintenance or other surveillance processes.*

The methodology on SSCs scoping for AM programmes IAEA SSG 48 „Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants" requires the following SSCs to be included in the scope of ageing management:

(a) SSCs important to safety that are necessary to fulfill the fundamental safety functions;

(b) Other SSCs whose failure may prevent SSCs important to safety from fulfilling their intended functions;

(c) Other SSCs that are credited in the safety analyses (deterministic and probabilistic) as performing the function of coping with certain types of events, consistent with national regulatory requirements.

After the new IAEA SSG was published, countries were expected to analyze whether their approach to scoping of SSCs complies with the new recommendations.

The scope of the OAMP was expected to be reviewed and, if necessary, updated, in line with the new IAEA Safety Standard after its publication.

3.1.1.2 Country position and actions on finding n°1

Cernavoda NPP methodology on scoping SSCs subject to AM, as described in the current revision of OAMP (IR-98100-009), provides for the selection of SSCs based on a graded approach, that originates in the process of first identifying the critical systems required to ensure the critical safety functions, as stated in Current Licensing Bases (RD-01364-L001, RD-01364-L008), and after that the critical components, that impact the plant's capacity to operate safely and reliably.

The process also establishes that the priority to address eventual SSCs problems depends on the impact of SSCs failure on maintaining critical safety functions, or which may affect the critical functions (SI-01365-T048 "Critical SSC Classification").

I. **Critical systems selection** was performed by RSE based on Functional Failure and Effect Analysis, taking into account the effect of their malfunction on the plants capability to operate safely, reliably, and efficiently from the nuclear safety, environmental, radiological and production perspective.

Using this approach**,** the list of critical systems selected in the scope of AM strategy was documented in the report IR-01345-015, which represents the main reference for prioritizing plant programs and projects.

II. **Critical components selection** was performed by RSE/ RCE, with expert panel support, according to the following general considerations:

- Determination of component criticality is consequence-based. The higher the consequence associated with the component failure, the higher the criticality is.
- Both active and passive functions of a component are to be considered.

- Consideration must be given to the role of a component in a system (e.g.: not all the components from a critical system are critical and each must be examined separately but in a non-critical system, there cannot be any critical component; otherwise such a system would have been reclassified as a critical system).

Based on the above considerations and safety impact, the **critical components** were classified in:

- **SPV (**Single Point of Vulnerability);
- **SC1 (**Safety Critical);
- **OC2 (**Other Critical);
- **PC3 (**Production Critical);
- **Non-critical components**: fulfillment of legal requirements for non-critical SSC;
- **Run-to-Maintenance** (RTM) part of non-critical systems, for which periodic testing may still be performed, if required.

Later on, based on the results of PSA Level 1 and Level 2 for normal operation, about 200 components per unit have been identified with moderate or high risk on Core Damage Frequency (Fussell-Vesely Risk >5E-03, Risk Achievement Worth>2) and were classified as SC1, in line with IAEA Guidelines.

Following the post-Fukushima Stress Tests, new safety improvements were considered necessary and were implemented in accordance with the risk analysis performed for Station Blackout and Severe Accident Management. Some of them consist of new equipment (such as mobile diesel generators) being added, and others in some extension of the current systems (e.g. new addition lines to inject water into the reactor vessel, the Emergency Filtered Containment Venting System, etc.)

The modifications have been included in the latest updates of the Final Safety Analysis Reports for U1 (2017) & U2 (2018), Chapter 19, “Probabilistic Safety Analyses (PSA) and Severe Accident Analyses” and the current lists of critical systems and critical components are being revised.

Cernavoda NPP methodology is in line with the Canadian Regulation CNSC REGDOC 2.4.2 Probabilistic Safety Assessment for NPPs specific EPRI guidelines and IAEA SSG-30 Safety Classification of Systems, Structures and Components in NPPs. Since the initial selection of SSCs to be included in the scope of the OAMP, the process is being updated continuously based on the feedback from implementation, surveillance, performance monitoring, internal and external OPEX, benchmarking, self-assessment, or R&D novelties.

Actions implemented and planned to validate or improve current methodology for scoping SSCs subject to AM:

a) In 2016, following a WANO Peer Review, a focus was set on the extent of condition for SSCs failures and it resulted in the enhancement of the Abnormal Condition procedures, process and database, which were modified to comply with WANO/INPO Performance Objectives and Criteria for Equipment Reliability Process. It is an improvement SSCs performance monitoring process, with direct positive impact on SSCs selection in scope of the Overall Ageing Management Program. The related action plan was implemented during the period 2016-2018, and was confirmed as efficient in the self-assessment. **(action completed).**

b) The last focus on the OAMP programs and process comprehensiveness was initiated in December 2018, when a new self-assessment was requested to the RSE/RCE, to identify any possible gaps between their current AMPs and the latest EPRI Guidance **(**EPRI

Report 3002013053" 2018 Update to EPRI Mapping to IAEA IGALL Aging Management Program Categories" **(action 2, in section 7).**

c) Verify if the equipment resulted from PSA level 1& 2 and from Severe Accident Analysis are included in the list of critical systems, respectively in the list of critical components, to ensure that they are subject to AM programs **(action 4, in section 7).**

d) An expert assessment of the SSCs selection methodology comprehensiveness will be performed during the PSR Project, launched in April 2019, with the following timeline: 1st PSR for U2 to be finalized by the end of 2020, and the 2nd PSR for U1 to be completed in 2021 **(action 5, in section 7**).

e) Another opportunity to validate or take action to enhance the methodology for scoping of SSCs subject to Ageing Management will take place during the Pre-SALTO Mission, scheduled for Cernavoda NPP U1 in 11-19 February 2020 when an IAEA expert mission will assess the compliance of the current methodology with international guidance and best practice models **(action 6, in section 7).**

3.1.2.1 Finding n°2: Delayed NPP projects and extended shutdown

TPR expected level of performance / Area for improvement: *During long construction periods or extended shutdown of NPPs, relevant ageing mechanisms are identified and appropriate measures are implemented to control any incipient ageing or other effects.*

3.1.2.2 Country position and action

The construction of Cernavoda NPP started in 1980 on a site designed for 5 units but only two units (Unit 1 and Unit 2) were completed so far. The construction of the remaining three units started in 1984 and was suspended in 1990. At present, it was decided that Unit 5 will no longer be developed as NPP, but the completion of Units 3 & 4 is still an option for a future contract. An overview of the ageing management programme for the existing structures of Units 3 & 4 is provided as follows.

Cernavoda NPP is located in Constanta county, latitude 44.3°N and longitude 28.01°E in the Dobrogea Region. The nuclear site lies about 2 km southeast of the Cernavoda town boundary, at 4 km southeast of Danube River and about 1.5 km northeast from the first lock on the Danube-Black Sea Channel (DBSC). The environmental stressors of plant site are the following:

- Riverside site with continental mild weather: no sea fog, no freezing/thaw cycles, 10.5°C multiannual average temperature in the area (approx. -2°C in January and 24.5°C in July);
- Relative Humidity to be considered: 72% (annual average), with >80%values in the cold season and <70% in the hot season;
- Maximum temperature in the hot summer days (40°C) and min. temperature in the winter (-20°C, sometimes even -30°C in January);
- Precipitations annual average of 400-500l/ m^2.

Scope of the ageing management activities: The scope of the ageing management activities consists in the constructed buildings and structures for cooling water. The level of completion of Unit 3 structures is more advanced than Unit 4. However the ageing management program is similar to both units.

Buildings:

- Reactor Building (RB)

The RB containment is a pre-stressed concrete structure consisting of the base slab, the perimeter wall, and the dome. Bonded pre-stressing system is used as principal reinforcement for concrete containment structure. Permanent protection of tendons against corrosion is provided by cement grout.

The main ARDM affecting the RB:

- Pre-stressing Force Losses
- Creep and Shrinkage
- Corrosion of the carbon steel embedded parts due to air humidity
- Corrosion of the carbon steel embedded parts due to fluctuant underground water level.

- Nuclear Services Building (NSB)

The NSB is a multistory metallic structure (carbon steel) assembled by bolting material, over a concrete basement. Metallic structure protection against corrosion is provided by a multilayer of acrylic paint. The main ARDM affecting the NSB:

- Corrosion of the carbon steel embedded parts due to air humidity
- Corrosion of the rebar and dowels at the surface of the concrete due to air humidity and in some cases due to rain water

- Turbine Building (TB)

The main ARDM affecting the TB: Same ARDMs affecting NSB

- Other Buildings
  - *High Pressure Emergency Core-Cooling (HPECC*) Building.
  - Emergency Water Supply (EWS) Pump house.
  - Chiller Building (CB).
  - Standby Diesel Generator (SDG) Building.
  - Pump house

The other buildings are of the same design like NSB. The basement is made of concrete and the superstructure metallic structure (carbon steel) assembled by bolting material. Therefore same ARDMs are applicable to those buildings.

Equipment: There is no equipment procured for Cernavoda Unit 3 and 4.

Preventive actions to minimize and control ageing effects: The underground water level shall be maintain constant and at low level. All openings were closed, to ensure a constant temperature and humidity inside.

Detection of ageing effects: In February 2010, the Atomic Energy of Canada Ltd (AECL), the designer of the CANDU technology, was awarded a contract to evaluate Cernavoda Units 3 &4 civil assets. During this assessment, visual inspection and testing was performed on the existing civil structures. Concrete degradation mechanisms include chemical attack (sulfate attack, alkali-aggregate reaction, carbonation, etc.), physical attack (freeze-thaw cycling, abrasion/erosion, thermal cycling, settlement, etc.). During the inspection, none of the above degradation mechanisms was identified as affecting the existing structures.

Monitoring and trending of ageing effects: The level of underground water is monitored and controlled, pumping out the excess water. Also, buildings settlement is monitored and reports are issued periodically, to record and trend buildings behavior. Acceptance of the effectiveness of the measures was performed by visual inspections and verification of the level of underground water.

The project of Units 3 and 4 is suspended but the agreement for completion of these 2 units is still under negotiation. When construction will be resumed, any potential nonconformity due to ageing effects will have to be resolved, in order to ensure that nuclear safety and licensing requirements are fully met.

CNCAN will revise the regulation NSN-17, in order to include explicit provisions on ageing management during long construction periods or extended shutdown of NPPs, to ensure that relevant ageing mechanisms are identified and appropriate measures are implemented to control any incipient ageing or other effects **(action 10, in section 7).**

3.1.3.1 Finding n°3: Overall Ageing Management Programmes of research reactors

TPR expected level of performance / Area for improvement: *A systematic and comprehensive OAMP is implemented for research reactors, in accordance with the graded approach to risk, the applicable national requirements, international safety standards and best practices.*

3.1.3.2 Country position and action

Actions have been taken for improving the overall AMP for the TRIGA Research Reactor, considering all the applicable requirements and good practices. Several improvement opportunities have resulted from the licensee's self-assessment and the regulatory reviews and inspections concerning the implementation of effective AMP and these will be tracked by CNCAN through its regular oversight processes. **(action 11, in section 7).**

3.1.4.1 Finding n°4: Effectiveness of the OAMP and use of performance indicators

Challenge: *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.*

3.1.4.2 Country position and action

Effectiveness of individual/specific AMPs is verified continuously through the Performance indicators both qualitative (at programmatic level) and quantitative (at component level), as Cernavoda NPP AMPs are developed at component level.

The condition of all critical components (addressed through PM or PLiM programs) is monitored continuously against specific performance indicators (PIs), established in correlation with the acceptance criteria, having administrative limits (set with sufficient margin to allow mitigating actions to be implemented).

The SSCs performance is reported once per year as part of Component / System Health Monitoring Process.

Any relevant and significant internal operating experience that would apply to component performance and issues is assessed and reported periodically. The assessment takes into account the extent of condition and extent of the problem in order to prevent future similar failures. The recommendations / actions to be taken to prevent the occurrence are formulated accordingly.

External operating experience (compiled by COG, INPO, WANO, IAEA, regulatory authorities from other countries, such as the Canadian Nuclear Safety Commission and the US Nuclear Regulatory Commission), identified during the reporting period, are evaluated for relevant events that would apply to component performance. Any recommendations to prevent its occurrence take into account the type of the problem (specific or generic issues).

Whenever generic issues are identified, actions are initiated at programmatic level, by the Responsible Program Coordinators: PM, PliM, PdM, EQ, PIP, or Process Responsible (e.g. Chemistry process responsible).

Currently, for the OAMP general programmatic PIs, there is an action in progress within COG Asset Management Peer Group to define a set of specific OAMP PIs for all CANDU plants, in line with IAEA SSG-48 and NEI Bulletin 14-12 Ageing Management Program Effectiveness, used by USA NPPs. **See action 7, in section 7.**

3.2 Concealed pipework

3.2.1.1 Finding n°1: Inspection of safety-related pipework penetrations

TPR expected level of performance / Area for improvement: *Inspection of safety-related pipework penetrations through concrete structures are part of ageing management programmes, unless it can be demonstrated that there is no active degradation mechanism.*

3.2.1.2 Country position and action on finding n°1

The general industry approach (including NEI 09-14 initiative) is that the scope of the BP programs should be limited up to where the buried pipe was embedded in the concrete wall or where the boot seal existing in the penetration. However, inclusion of the pipe from wall penetrations into the Buried Piping Inspection Program is a subject still under debate in the nuclear industry.

Despite of this lack of industry guidance, Cernavoda NPP has been conservatively considered in the scope of its BP Program all the concealed pipework important to safety, as well as not safety-related, where the pipework is:

- Buried in soil,
- Encased in concrete, or
- In covered trenches.

The method chosen to inspect the pipe segments included in penetrations was Guided Waves (GW), an indirect inspection technique used to screen long lengths of pipe for corrosion or cracks on 100% circumference. The equipment was a Wave-maker G3^{TM} Pipe Screening System, containing transducer rings, the wave-maker instrument and the controlling computer. This GW assembly was used by external, certified and experienced GW personnel.

Based on the risk-ranking results obtained in 2016 with BPWORKS software for the buried piping segments in Unit 1 and Unit 2, multi-annual inspection plans have been developed and the inspection scope was established. Also the inspection type (direct/indirect) were settled down and the appropriate time schedule for the last years of the existing inspection contract (2017-2019). These planned inspections have included the piping segments from the safety-related systems, as well as from the non-safety-related systems, depending on their susceptibility to degradation (more information are provided in the NAR report).

As part of the mentioned pipelines examination, the following piping penetrations have been inspected with GW:

System name	System code (BSI)	Pipe diameter	Pipe material	Pipe penetration type	Place of GW inspection	Approx. length of GW inspected pipe penetration
Raw Service Water (RSW)	71310	52” 48”	Carbon steel OL 42.2K	Concrete embedded	Inside Pump House building Inside SDG building	up to 4 meters up to 4 meters
RSW Backup Cooling (BCWS)	71690	16”	Carbon steel A106 Gr.B	Concrete embedded	Inside valve pits, to embedded parts of pipe	up to 5.5 meters

The results of the examined penetrations have demonstrated a good condition of all the inspected buried pipes accessible with GW, with no detectable corrosion or surface defects. However, it is worth mentioning from the Cernavoda NPP experience that the range (length) of buried piping or pipe penetration, that can be examined using GW method, is highly dependable on the following factors:

1. The type of external buried pipe coating or insulation, as follows:
   - bitumen coating has significant influence regarding GW signal attenuation (depending on bitumen thickness), while
   - other non-adherent types of pipe coating (ex. FOAMGLASS thermal insulation) has practically no impact on the GW signal attenuation, allowing longer section of piping to be examined.
2. The existence of expansion joints around the pipe, at the penetration area: this type of installation is preventing the GW signal to reach the pipe inside the penetration, and therefore examination of these type of pipe penetrations is practically impossible.
3. The type of material in which pipe is embedded (into penetration or on a limited length): concrete is a material that was extensively used at the time of construction to route the buried piping inside a nuclear plant, but has a high attenuation of the GW signal, especially when combined with the bitumen coating of the concrete embedded line.

Inspection of safety-related pipework penetrations through concrete structures have been conservatively considered and performed by the Cernavoda NPP, as part of its Concealed Piping program, even that there are no specific requirements from the industry standards. CNCAN has regularly inspected the licensee’s activities for the assessment of ageing management of concealed pipework and found their performance satisfactory.

For the reasons above, **Romania considers that the finding on inspection of safety-related pipework penetrations is considered closed.** However, we are closely monitoring advances in operating experience, in standards and in research and development at international level and any applicable, relevant, new information will be used to improve the existing ageing management programmes for safety-related concealed pipework.

3.2.2.1 Finding n°2: Non-invasive inspection methods for long lengths or complex geometries

TPR expected level of performance: *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.*

3.2.2.2 Country position and action on finding n°2

Non-invasive (indirect) inspection methods have been considered and applied by Cernavoda NPP, as a means to determine the condition of the plant concealed piping. The main indirect method that was used for inspections was the guided waves ultrasonic technique, which apart of the obvious advantage of examining not accessible and longer range of the concealed pipes, has been proven to have limitations when used for pipes with high density coating (as bitumen) or pipes embedded in concrete.

Cernavoda NPP is an active EPRI member and the allocated Concealed Piping program engineer is involved in the EPRI Buried Piping Integrity Group (BPIG) meetings, actively following the EPRI product related to NDE evaluation and diagnostic technologies to assess aging impacts. Therefore, as other non-invasive examination methods will evolve in offering a longer range of inspection and a more precise identification of defects, Cernavoda NPP will consider extending this type of inspections on the concealed piping in the plant.

CNCAN has verified that the licensee is actively following the EPRI products related to development of non-invasive inspection methods for detection of local corrosion, suitable for use on complex geometries or long lengths of concealed piping and will monitor the actions taken to implement any new, adequate/proven inspection methodology.

Romania considers that there is a comprehensive process in place to ensure alignment to R&D. Non-invasive inspection methods, as diagnostic technologies evolve and become available and affordable.

3.3 Reactor pressure vessel or Calandria/Pressure Tubes

There have been no actions for improvement or challenges identified from the TPR in this area.

CNCAN will continue to monitor the AM program developed by the licensee for Calandria / Pressure Tubes and any changes / improvements to this program.

3.4 Concrete containment structure and pre-stressed concrete pressure vessels

3.4.1.1 Finding n°1: Acceptance criteria for the degradation mechanisms

Challenge: *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.*

3.4.1.2 Country position and action on finding n°1

The action plans elaborated by Cernavoda NPP to address LA recommendations for Cernavoda U1 and U2 Reactor Building Concrete Structures will cover the actions required to address this generic Challenge. See section 2.5.1 a) and **action 9, in section 7.**

4. GENERIC FINDINGS RELATED TO ELECTRICAL CABLES

4.1 Good practice: characterize the state of the degradation of cables aged at the plant
Cables are aged within the actual power plant environment and tested to assess cable condition and determine residual lifetime.

4.1.1 Country implementation: Not yet implemented.

4.1.2 Country planned action if relevant: Cernavoda NPP issued an external service request CR #00021052 – LIFE ASSESSMENT EVALUATION, INSPECTION AND TEST SERVICES FOR U#1 & U#2 CERNAVODA NPP ELECTRICAL CABLES in order for a specialized firm to determine residual lifetime of electrical cables. **See action #10 in Section 7.**

4.2 TPR expected level of performance: documentation of the cable ageing management program
The AMP is sufficiently well-documented to support any internal or external reviews in a fully traceable manner.

4.2.1 Country implementation:

The Cables Program Manual of Cernavoda NPP has been revised in 2018 to take into account the recent and relevant standards and guidelines (IAEA, IGALL AMPs, NUREG, EPRI, IEEE Std 400-2001), as well as to include the results of specific COG R&D reports for cables ageing management for CANDU NPPs and the international OPEX accumulated during 2009-2017.

The electrical cable AMP is documented in a complete way:

- identification number,
- manufacturer documentations,
- materials, characteristics,
- degradation mechanisms,
- diagnostic methods, remedial actions, new international experience for the material, measurement methods and complete / periodical review schedule) ;

All investigations, calculations, type-tests and procedures are traceable to the installed cables in the plant.

CNCAN has reviewed and inspected the AMP for electrical cables and found the programme and its associated documentation satisfactory.

4.2.1 Country planned action if relevant: N/A

4.3 TPR expected level of performance: methods for monitoring and directing all AMP-activities
Methods to collect NPP cable ageing and performance data are established and used effectively to support the AMP for cables.

4.3.1 Country implementation:
Records of maintenance, testing and operational data of electrical cables are managed within the Work Management System of Cernavoda NPP.

4.3.2 Country planned action if relevant:
Cernavoda NPP issued an acquisition request CR #00021052 – LIFE ASSESSMENT EVALUATION, INSPECTION AND TEST SERVICES FOR U#1 & U#2 CERNAVODA NPP ELECTRICAL CABLES, which includes activities for maintaining and populating the database with records of cables. **See action #10 in Section 7.**

4.4 TPR expected level of performance: Systematic identification of ageing degradation mechanisms considering cable characteristics and stressors
Degradation mechanisms and stressors are systematically identified and reviewed to ensure that any missed or newly occurring stressors are revealed before challenging the operability of cables.

4.4.1 Country implementation
According to the current revision of the electrical cable AMP for Cernavoda NPP, degradation mechanisms have been identified considering stressors like temperature, radiation, water, electrical fields and cable materials like insulation, jackets.

4.4.2 Country planned action if relevant: N/A

4.5 TPR expected level of performance: prevention and detection of water treeing
Approaches are used to ensure that water treeing in cables with polymeric insulation is minimized, either by removing stressors contributing to its growth or by detecting degradation by applying appropriate methods and related criteria.

4.5.1 Country implementation: Not yet implemented.

4.5.2 Country planned action if relevant
Cernavoda NPP issued an external service request CR #00021052 – LIFE ASSESSMENT EVALUATION, INSPECTION AND TEST SERVICES FOR U#1 & U#2 CERNAVODA NPP ELECTRICAL CABLES in order for a specialized firm to determine required approaches to ensure that water treeing in cables with polymeric insulation is minimized.

See action #8 in Section 7.

4.6 TPR expected level of performance: consideration of uncertainties in the initial EQ
The accuracy of the representation of the stressors used in the initial Environmental Qualification is assessed with regard to the expected stressors during normal operation and Design Basis Accidents.

4.6.1 Country implementation
Cernavoda NPP has developed a software application to allow integrated and systematic collection and management of environmental data (stressors) for safety related equipment required to sustain accident scenarios. The collected data will ensure the required information to assess more accurately the expected stressors during normal operation and Design Basis Accidents.

The action has been implemented.

4.6.2 Country planned action if relevant: Cernavoda NPP issued an external service request CR #00021052 – LIFE ASSESSMENT EVALUATION, INSPECTION AND TEST SERVICES

FOR U#1 & U#2 CERNAVODA NPP ELECTRICAL CABLES in order for a specialized firm to assess Environmental Qualification of the electrical cables with regard to the stressors during normal operation and Design Basis Accidents.

See action #8 in Section 7.

4.7 TPR expected level of performance: determining cables' performance under highest stressors

Cables necessary for accident mitigation are tested to determine their capabilities to fulfil their functions under Design Extension Conditions and throughout their expected lifetime.

4.7.1 Country implementation

According to the design requirements, determining cables' performance under highest stressors is done at commissioning by the electrical cable manufacturer. Following the commissioning period, only functional tests are considered for validate operational availability.

4.7.2 Country planned action if relevant

Cernavoda NPP issued an external service request CR #00021052 – LIFE ASSESSMENT EVALUATION, INSPECTION AND TEST SERVICES FOR U#1 & U#2 CERNAVODA NPP ELECTRICAL CABLES in order for a specialized firm to determine electrical cables capabilities to fulfil their functions under Design Extension Conditions and throughout their expected lifetime.

See action #8 in Section 7.

4.8 TPR expected level of performance: techniques to detect the degradation of inaccessible cables

Based on international experience, appropriate techniques are used to detect degradation of inaccessible cables.

4.8.1 Country implementation

The choice of techniques used to detect degradation of inaccessible cables includes:

- Insulation resistance measurement (for MV, LV, I&C);
- Conductor resistance/impedance measurement (for MV, LV, I&C);

4.8.2 Country planned action if relevant

Following the implementation of LIFE ASSESSMENT EVALUATION, INSPECTION AND TEST SERVICES FOR U#1 & U#2 CERNAVODA NPP ELECTRICAL CABLES (CR #00021052) the AMP will be revised to implement additional techniques in order to better detect degradation of inaccessible electrical cables.

See action #8 in Section 7.

5. ALL OTHER GENERIC FINDINGS

5.1 Overall Ageing Management Programmes (OAMPs)

5.1.1 Good practice: External peer review services

External peer review services (e.g. SALTO, OSART-LTO, INSARR-Ageing) are used to provide independent advice and assessment of licensees' ageing management programmes.

5.1.1.1 Allocation by the TPR: No allocation for Romania

5.1.1.2 Country position

Cernavoda NPP has been inviting peer review missions such as WANO and OSART at regular intervals (every 2-3 years), since 2005. Other than this, over the time, Cernavoda NPP had also the benefit of Technical Support Missions from COG, a service included in the Information Exchange base Program (e. g. in 2013, to independently assess the compliance of the technical program for Snubbers).

The first Pre-SALTO Mission in Romania is scheduled for Cernavoda NPP U1, in 11-19 February 2020 **(action 6, in section 7).**

5.1.2 TPR expected level of performance: Data collection, record keeping and international cooperation

Participation in international R&D projects, experience exchange within groups of common reactor design and the use of existing international databases are used to improve the effectiveness of the NPPs OAMP.

5.1.2.1 Allocation by the TPR: No allocation for Romania Country position and action

5.1.2.2 As owner of a CANDU NPP, SNN Company, the license holder for Cernavoda NPP, is member of CANDU Owners Group (COG) since 1997. As such, specific, arrangements are in place with COG to benefit from the international OPEX lessons learned on CANDU technology specific Components, but also with generic EPRI products.

It is worthwhile mentioning that, on complex ageing issues, Cernavoda NPP is participating to COG R&D Program since 2006 and is collaborating with local design and research institutes since the beginning of its economic operation.

Since 2016, CNPP has nominated representatives in IGALL discipline Working Groups and they participated to the annual WG meetings and documents review, as requested. Romania has also representatives in IGALL at Steering Committee level from SNN corporate and from CNCAN.

In the last couple of years, SNN is improving also the cooperation with NEA –OECD, where representatives have been nominated at SNN Company level, and Cernavoda NPP level, to participate in Working Group discussions, in order to maintain personnel competences and knowledge in a large area of topics (e.g. Working Group on Integrity and Ageing of Components and Structures, with the subgroup: Assessment of Structures Subject to Ageing Pathologies – WIAGE-ASCET).

5.1.3 TPR expected level of performance: Methodology for scoping the SSCs subject to ageing management

The scope of the OAMP for NPPs is reviewed and, if necessary, updated, in line with the new IAEA Safety Standard after its publication.

5.1.3.1 Allocation by the TPR**: Area for improvement**
5.1.3.2 Country position and action **See section 3.1.1.1, 3.1.1.2**

5.1.4 TPR expected level of performance: Delayed NPP projects and extended shutdown

During long construction periods or extended shutdown of NPPs, relevant ageing mechanisms are identified and appropriate measures are implemented to control any incipient ageing or other effects.

5.1.4.1 Allocation by the TPR: **Area for improvement**
5.1.4.2 Country position and action: **See section 3.1.2.1, 3.1.2.2**

5.1.5. TPR expected level of performance: Overall Ageing Management Programmes of research reactors

A systematic and comprehensive OAMP is implemented for research reactors, in accordance with the graded approach to risk, the applicable national requirements, international safety standards and best practices.

5.1.5.1 Allocation by the TPR: **Area for improvement**

5.1.5.2 Country position and action: See section 3.1.3.1, 3.1.3.2 and **action 11, in section 7**.

5.2 Concealed pipework

5.2.1 Finding n°1: Use of results from regular monitoring of the condition of civil structures

Good practice: *In addition to providing information on soil and building settlement, the results from regular monitoring of the condition of civil structures are used as input to the ageing management programme for concealed pipework.*

5.2.1.1 Allocation by the TPR: No allocation for Romania

5.2.1.2 Country position:

At Cernavoda NPP, civil structures condition assessment from the perspective of soil and building settlement is a current practice and is performed by periodic checks. The main buildings in the plant, including the Reactor Building, are monitored for vertical displacements in time, using reference marks which are permanently placed on the building walls. The results of these checks are documented in written reports and any anomaly is reported through the plant Abnormal Condition Report process. In this way, information is accessible to all plant personnel, including to the concealed piping program engineer. Up to present, there was no indication reported regarding soil or building settlement on Cernavoda NPP premises and the Containment Buildings recorded settlement up to present (after 38 years) is well below the limits. Considering the above justification, no further action is considered necessary.

5.2.2 Finding n°2: Performance checks for new or novel materials

Good practice: *In order to establish the integrity of new or novel materials, sections of pipework are removed after a period of operation and inspected to confirm the properties are as expected*.

5.2.2.1 Allocation by the TPR: No allocation for Romania

5.2.2.2 Country position:

The only new or novel material used at NPP for the concealed pipework was the High Density Polyethylene (HDPE). This plastic material was used to replace all the corroded carbon steel buried piping from the plant Fire Water Main Ring. This work was completed in 2014 and up to present, the HDPE fire water piping has proven to be a reliable choice, since no indications of defects or operational issues have occurred on this system.

Regarding the removal of a section from a concealed pipeline in a nuclear plant, this is an activity that has to be done with pipe isolation and drainage of fluid from the line, which means that the system becomes partially or totally unavailable. This activity, especially for a safety-related system, like Fire Water System, is considered as having a potential impact on nuclear safety, and that is why it usually involves plant shutdown.

Therefore, removal of a concealed pipe section with the scope of determining the integrity of new or novel materials has to be well justified by internal /external OPEX events or adverse results from research and studies on the new material properties. Moreover, this kind of activity has to be planned and prepared in advance, in order to avoid any adverse effects on the plant.

As an active member of EPRI, Cernavoda NPP is closely following the studies, researches and reports issued on the subject of testing and assessment of the HDPE material properties. If problems regarding the HDPE piping performance will be reported in the industry and will require removal of pipe section for further material checks and evaluations, Cernavoda NPP will act accordingly.

Considering the above justification, no action is considered necessary.

5.2.3 Finding n°3: Inspection of safety-related pipework penetrations

TPR expected level of performance: *Inspection of safety-related pipework penetrations through concrete structures are part of ageing management programmes, unless it can be demonstrated that there is no active degradation mechanism.*

5.2.3.1 Allocation by the TPR: Area for improvement

5.2.3.2 Country position and action: **See sections 3.2.1.1, 3.2.1.2**

5.2.4 Finding n°4: Scope of concealed pipework included in AMPs

TPR expected level of performance: *The scope of concealed pipework included in ageing management includes those performing safety functions, and also non-safety-related pipework whose failure may impact SSCs performing safety functions.*

5.2.4.1 Allocation by the TPR: Good Performance
5.2.4.2 Country position and action N/A

In accordance with the approved related Program Manual and the EPRI recommendations, Cernavoda NPP developed “Buried Piping” program for all underground piping contained within the critical, non-critical and safety related systems of Unit 1 and Unit 2 and includes:

- Piping buried in soil;
- Piping encased in concrete;
- Piping located in trenches.
- Piping located inside valve pits or access pits.

Cernavoda NPP BP program includes in its scope also the following major commodities:

1. All existing underground tanks, which contain fuel oil and supply the Standby Diesel Generators (SDG) and the Emergency Power Supply (EPS) generators located, for both Unit 1 and Unit 2 of the plant.
2. The Cathodic Protection systems (galvanic type) installed on the EPS & SDG piping and tanks, for both Unit 1 and Unit 2 of the plant.

The scope of Cernavoda NPP BP Program does not apply to other types of underground commodities such as: conduits, concrete pits, cables and intake structures, which are monitored by separate programs.

In accordance with international best practice, non-critical systems like Potable Water Supply, Hot Water or Sewage are also included in the scope of BP Program, where it was considered that a defect occurred on these piping, which could potentially affect the safety functions of other plant safety systems and safety-related system.

5.2.5 Finding n°5: Opportunistic inspections

TPR expected level of performance: Opportunistic inspection of concealed pipework is undertaken whenever the pipework becomes accessible for other purposes.

5.2.5.1 Allocation by the TPR: Not Concerned

5.2.5.2 Country position and action N/A

5.3 Reactor pressure vessel or Calandria/Pressure Tubes

5.3.1 Good practice: Hydrogen water chemistry

Hydrogen Water Chemistry (HWC) is used in BWRs which may be sensitive to Intergranular Stress Corrosion Cracking

5.3.1.1 Allocation by the TPR: Not Concerned
5.3.1.2 Country position: N/A

5.3.2 Good practice: Implementation of a shield

Shielding in the core of PWRs with relatively high fluence is implemented to preventively reduce neutron flux on the RPV wall.

5.3.2.1 Allocation by the TPR: Not Concerned
5.3.2.2 Country position: N/A

5.3.3 TPR expected level of performance: Volumetric inspection for nickel base alloy penetration

Periodic volumetric inspection is performed for nickel base alloy penetrations which are susceptible to Primary Water Stress Corrosion Cracking for PWRs to detect cracking at as early a stage as possible.

5.3.3.1 Allocation by the TPR: Not Concerned
5.3.3.2 Country position and action: N/A

5.3.4 TPR expected level of performance: Non-destructive examination in the base material of beltline region

Comprehensive NDE is performed in the base material of the beltline region in order to detect defects
5.3.4.1 Allocation by the TPR: Not Concerned
5.3.4.2 Country position and action: N/A

5.3.5 TPR expected level of performance: Environmental effect of the coolant

Fatigue analyses have to take into account the environmental effect of the coolant.

5.3.5.1 Allocation by the TPR: Not Concerned
5.3.5.2 Country position and action: N/A

5.3.6 TPR expected level of performance: Suitable and sufficient irradiation specimens

For new reactors, suitable and sufficient irradiation specimens and archive materials are provided to support the reactor through its full operational life.

5.3.6.1 Allocation by the TPR: Not Concerned
5.3.6.2 Country position and action: N/A

5.4 Concrete containment structure and pre-stressed concrete pressure vessel

5.4.1 Finding n°1: Monitoring of concrete structures

Good practice: *Complementary instrumentation is used to better predict the mechanical behaviour of the containment and to compensate for loss of sensors throughout the life of the plant.*
5.4.1.1 Allocation by the TPR: None
5.4.1.2 Country position: **See section 2.5**

Recently, Cernavoda NPP contracted a study with SNC Lavalin (CANDU Energy) in order to assess the status of the existing deformation monitoring system for Unit 1 Reactor Building and to develop an Instrumented Monitoring Program that will improve the monitoring of the Containment structure. The study was delivered in 2019 and it recommends the installation of a new monitoring system, based on surface-mounted sensors, to capture the global behaviour of the structure. Based on the SNC Lavalin report recommendations, Cernavoda NPP is currently analyzing the opportunity for installation of the new instrumentation for deformation measurements.

CNCAN is monitoring the implementation of this activity, which is also in line with the requirements resulting from regulations and inspections.

5.4.2 Finding n°2: Assessment of inaccessible and/or limited access structures

Good practice: *A proactive and comprehensive methodology is implemented to inspect, monitor and assess inaccessible structures or structures with limited access.*

5.4.2.1 Allocation by the TPR: None

5.4.2.2 Country position: **See section 2.5** (and **action 9, in section 7**).

The inaccessible areas of the concrete containment components are evaluated by comparison with the adjacent accessible areas for visual inspection. Cernavoda NPP also performs non-destructive examination (Infrared thermography) of the concrete surface covered with non-metallic liner, in the fuel transfer structures.

Currently Cernavoda NPP is in the process of gathering Operating Experience from CANDU NPPs with respect to the possibility of using other non-destructive inspection methods with proven efficiency in the nuclear industry (such as ultrasound examination). After completion, the results will be included in the future revision of Containment AMP.

CNCAN will continue to monitor the revision and implementation of the Containment AMP of the licensee and will verify that any new relevant information from international standards, operating experience and research and development is used to improve the programme.

5.4.3 Finding n°3: Monitoring of pre-stressing forces

TPR expected level of performance: *Pre-stressing forces are monitored on a periodic basis to ensure the containment fulfils its safety function.*

5.4.3.1 Allocation by the TPR: Good Performance
5.4.3.2 Country position and action**: See section 2.5** (and **action 9, in section 7**).

Currently Cernavoda NPP has a specific AMP program for the Reactor Building that comprises ISI (in-service inspection) activities – visual inspections, measurements of the loss of pre-stressing force using a deformation sensors system and test beams. However, the AMP needs alignment with the latest international guides.

To this effect, Cernavoda NPP contracted a study with SNC Lavalin (CANDU Energy), to develop a Reactor Building Ageing Management Plan. The document has been delivered in 2019 and forms the technical basis for the revision of the current Reactor Building Program Manual. The "Reactor Building Ageing Management Plan" will be developed in accordance with the latest international approach in Ageing Management and it will be structured similar to the IAEA IGALL AMPs.

Cernavoda NPP is monitoring the loss of pre-stressing force using the deformation measurement system, during pressure tests (IRBLRT), and examination of the test beams (cast at the same time of construction of Unit 1/Unit 2 Reactor Buildings) which are periodically tested by destructive or non-destructive methods .

The specified tests on test beams include: visual examination, stress relaxation measurements on the three specimens cast with un-bonded prestressing tendons, flexural test, destructive examination.

6. STATUS OF THE REGULATION AND IMPLEMENTATION OF AMP TO OTHER RISK SIGNIFICANT NUCLEAR INSTALLATIONS

6.1 Board recommendation

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.

6.2 Country position and action

The regulation NSN-17 issued by CNCAN in 2016 on ageing management for nuclear installations applies also to nuclear fuel fabrication plants and nuclear spent fuel storage facilities.

CNCAN has requested all the licensees to prepare self-assessments of their compliance with the regulation and performs regular reviews and inspections to verify fulfillment of the regulatory requirements.

7. TABLE: SUMMARY OF THE PLANNED ACTIONS

No	Installation	Thematics	Finding	Planned action	Deadline	Regulator's Approach to Monitoring
1	Cernavoda NPP U1&U2	OAMP	Finding 2 from Self-assessment: *Documenting the strategies to keep alignment of PIP Program with the recent Code Standard editions*	Revision of PIP Program Manual to comply with the recent Code Standard editions	2020	Annual inspections
2	Cernavoda NPP U1&U2	OAMP	Finding 3 from Self-assessment: *Continuous alignment to the international OPEX (EPRI, IGALL)*	Assess the applicability of the latest guidelines for Ageing Management, in accordance with EPRI Report 3002013053 – 2018 Update to EPRI Product Mapping to IAEA IGALL	Continuous action Report in 2019 CHMR/ SHMR	Annual inspections
3	Cernavoda NPP U1&U2	OAMP	Finding 3 from Self-assessment: *Continuous alignment to the international OPEX (EPRI, IGALL)*	Revision of Cernavoda AMPs as resulted from compliance assessment against IGALL AMPs and EPRI Report 3002013053	January 2021	Annual inspections
4	Cernavoda NPP U1&U2	OAMP	Finding 1 from TPR – Area for improvement: *Methodology for scoping the SSCs subject to ageing management*	Verify if the equipment resulted from PSA level 1& 2 and from Stress Tests are included in the list of critical systems, respectively in the list of critical components, to ensure that they are subject to AM programs.	December 2020	Annual inspections
5	Cernavoda NPP U1&U2	OAMP	Finding 1 from TPR – Area for improvement: *Methodology for scoping the SSCs*	A comprehensive assessment of the SSCs selection methodology will be performed during PSR	PSR for U2 2020, PSR for U1 2021	Annual inspections

			subject to ageing management	Project, launched in April 2019, for U2 (1st PSR), followed by U1 (2nd PSR).		
6	Cernavoda NPP U1&U2	OAMP	Finding 1 TPR – Area for improvement: *Methodology for scoping the SSCs subject to ageing management*	Independent assessment of the methodology for scoping of SSCs subject to Ageing Management will take place during Pre-SALTO Mission	11-19 Feb. 2020	Annual inspections
7	Cernavoda NPP U1&U2	OAMP	Finding 4 from TPR - Generic Challenge: *Effectiveness of the OAMP and use of performance Indicators*	Define a set of specific OAMP Performance Indicators, in line with IAEA SSG-48 and NEI Bulletin 14-12 Ageing Management Program Effectiveness, used by USA NPPs	December 2021	Annual inspections
8	Cernavoda NPP U1&U2	Cables	Finding 1 from Self-assessment: *Implement a proactive AMP for cables*	Contract complete external services (CR 21052) for advanced aging testing methodologies. Obtain Condition Assessment reports, as a prerequisite for program enhancement actions needed for LTO	2019 December 2021	Annual inspections
9	Cernavoda NPP U1&U2	Concrete Containment Structure	Finding 1 from Self-assessment: *Enhance RB AMP Program based on Unit 1 Life Assessment study recommendations*	Implement Unit 1 and Unit 2 Life Assessment study recommendations, as detailed in the action plans, in order to ensure long term health of Cernavoda Reactor Buildings This action will cover also “Acceptance criteria for the degradation mechanisms” – Generic Challenge.	December 2021	Annual inspections

10	Cernavoda NPP and ICN TRIGA Research Reactor	OAMP	Finding 2 from TPR: *During long construction periods or extended shutdown of NPPs, relevant ageing mechanisms are identified and appropriate measures are implemented to control any incipient ageing or other effects.*	CNCAN will revise the regulation NSN-17, in order to include explicit provisions on ageing management during long construction periods or extended shutdown of NPPs, to ensure that relevant ageing mechanisms are identified and appropriate measures are implemented to control any incipient ageing or other effects. Additional requirements will be included based on IAEA SSG-48 and on the ENSREG 1st Topical Peer Review Report "Ageing Management" from October 2018	December 2020	-
11	ICN TRIGA Research Reactor	OAMP	Finding 3 from TPR: *A systematic and comprehensive OAMP is implemented for research reactors, in accordance with the graded approach to risk, the applicable national requirements, international safety standards and best practices.*	Actions have been taken for improving the overall AMP for the TRIGA Research Reactor, considering all the applicable requirements and good practices.	December 2020	Annual inspections

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9. LIST OF ACRONYMS

AECL - Atomic Energy of Canada Limited
AFI – Area for Improvement
AFCIS - Advanced Fuel Channel Inspection System
AMP - Ageing Management Program
ANS – American National Standard
ANSI – American National Standards Institute
ARDM - Aging Related Degradation Mechanism
ASME – American Society of Mechanical Engineers
ASR – Alkali Silica Reaction
BP – Buried Piping
CANDU - Canadian Deuterium Uranium Reactor
CEI – CANDU Energy Inc.
CIV - Cells High Voltage
CLB – Current Licensing Basis
CM&C - Chemistry, Materials and Components
CNCAN - National Commission for Nuclear Activities Control
COG – CANDU Owners Group
CPRs - Component Plan Recommendations
CSA – Canadian Standards Association
CR – Contract Request
CT – Calandria Tube
CVS – Calandria Vault Structure
DCC - Digital Control Computers
DCS - Distributed Control System
DHC - Delayed Hydride Cracking
ECR - Engineering Change Request
EFPH - Effective Full Power Hours
EPRI – Electric Power Research Institute
EQ – Environmental Qualification
ENSREG – European Nuclear Safety Regulators Group
FAC - Flow-Accelerated Corrosion
FC – Fuel Channel
FFA - Functional Failure Analysis
FSAR - Final Safety Analysis Report
FTS – Fuel Transfer Structure
FP – Full power
IAEA - International Atomic Energy Agency
IEEE – Institute of Electrical and Electronics Engineers
IEC – International Electrotechnical Commission
IGALL - IAEA's International Generic Ageing Lessons Learned program
IMSP - Integrated Material Surveillance Program
INPO – Institute of Nuclear Power Operations
ISCIR - State Inspectorate for Boilers, Pressure Vessels and Hoisting Installations
ISO – International Organization for Standardization
LCMP - Life Cycle Management Plan
LRT – Leak Rate Test
MERP - Maintaining Equipment Reliability Process
MS&I - Maintenance Surveillance and In-Service Inspection Program

NDE – Non Destructive Examination
NMC - Norms on Quality Management
NPP - Nuclear Power Plant
ODM - Operational Decision Making
OEM - Original Equipment Manufacturer
PHM - Program Health Monitoring
PIs – Performance Indicators
PIPD - Periodic Inspection Program Document
PLCP - Plant Life Cycle Plan
PLIM - Plant Life Management Program
PM – Preventive Maintenance
PHC – Plant Health Committee
PHT – Primary Heat Transport (System)
PHWR - Pressurized Heavy Water Reactor
PSA - Probabilistic Safety Assessment
PSR - Periodic Safety Review
PT – Pressure Tube
QMS - Quality Management System
RATEN - Technologies for Nuclear Energy State Owned Company
RATEN - CITON - Centre of Technology and Engineering for Nuclear Projects
RATEN - ICN – Institute for Nuclear Research
RB – Reactor Building
RCE - Responsible Component Engineer
RSE - Responsible System Engineer
RTM - Run-to-Maintenance
SDG – Standby Diesel Generators
SHMP/CHMP - System/Component Health monitoring plan
SHMR/ CHMR - System /Component Health Monitoring Report
SNN - National Company "NUCLEARELECTRICA" S.A.
SPOC - Single Point of Contact
SPV - Single Point of Vulnerability
SSCs – Systems, Structures and Components
TLAA - Time-Limited Ageing Analysis
TOE - Technical Operability Evaluation
TPR – Topical Peer Review
TRIGA - Training, Research, Isotopes, General Atomics
VWSG - Vibrating Wire Strain Gauges
WANO - World Association of Nuclear Operators
WENRA - Western European Nuclear Regulators Association
WENRA SRL - WENRA Safety Reference Levels