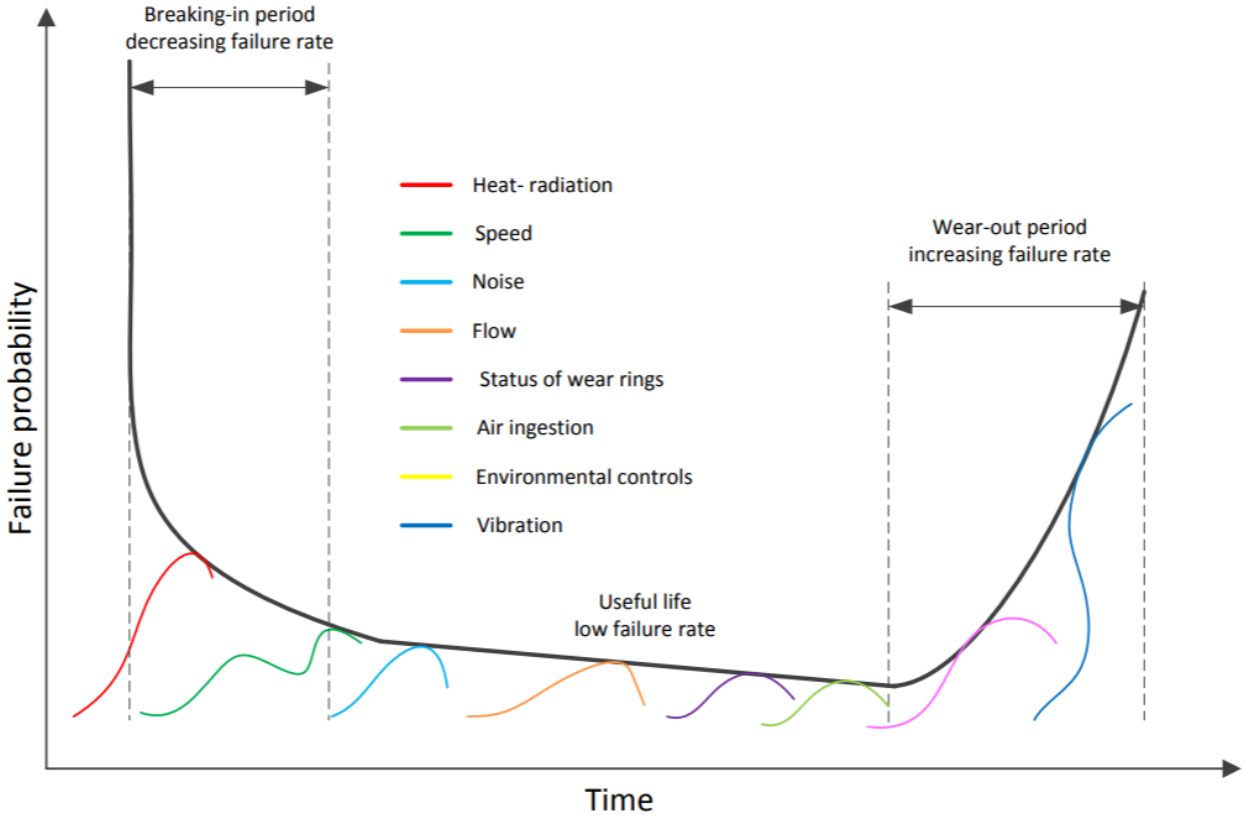
REPUBLIC OF SLOVENIA
MINISTRY OF THE ENVIRONMENT AND SPATIAL PLANNING
SLOVENIAN NUCLEAR SAFETY ADMINISTRATION

ENSREG 1st Topical Peer Review
National Action Plan on
the Krško NPP Ageing Management Program

September 2019



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Prepared by the **Slovenian Nuclear Safety Administration**

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1. INTRODUCTION

In 2014, the European Union (EU) Council adopted directive 2014/87/EURATOM1 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 every six years thereafter. 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 firstTPR. In the first phase national self-assessments were conducted against the WENRA Technical Specification. Based on that in December 2017 Slovenia has prepared a National Assessment Report (NAR) within the TPR on aging management. Within the report the ageing management in the Krško NPP were covered.

The second phase started in January 2018 when the NAR 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 numbers of 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 NAR, 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. Slovenia receives 1 good practice, 4 good performances, 5 areas for improvement (AFI for cables are not included) and 4 challenges.

In the third phase of the TPR, a TPR Report and country specific findings have been compiled to provide input for national action plans and ENSREG work.

In this report the Slovenian National Action Plan is developed based on findings from TPR Report. The National Action Plan shall define the scope and timing of necessary improvements identified during this exercise.

2. FINDINGS RESULTING FROM THE SELF-ASSESSMENT

2.1. Overall Ageing Management Programmes (OAMPs)

There were no findings identified from the self-assessment on OAMPs.

2.2. Electrical cables

2.2.1. Finding n°1: **ADP-1.4.459 procedure improvement**

Maintenance procedure describes the sampling of cables. The Krško NPP used criteria from technical report EPRI TR-107514, Chapter 4 (Sampling program description). This criterion is applicable in case when cables are not degraded. Criteria for sample selection in case of degradation finding will be revised in 2018 and if necessary the list of sampled cables will be extended.

2.2.2. Country position and action on finding N°1 (licensee, regulator, justification)

Current status in the Krško NPP: Krško NPP prepared a new revision of the ADP-1.4.459 procedure in March 2018. The criteria for sample selection in case of degradation was revised. The criteria is based on function from technical report EPRI TR-107514, Chapter 4 (Sampling program description). For example: if one degraded cable is identified in a group of 50 cables, the number of samples is 28, if there are 5 degraded cables, all shall be addressed. The list of sampled cables doesn't need to be extended due to no insulation degradation were found. Scoped cables in ADP-1.4.459 are in accordance with updated sampling criteria as well. Cables are scoped from adverse environment. All cables that were found with jacket deviations and all cables under similar operating conditions, were already tested, rerouted or replaced (removed from adverse environment) so list of cables doesn't need to be extended.

Krško NPP decided not to revise the lists of sampled cables in both programs and kept them as the initial lists of cables for information. Actual scope of cables is in the eBS PM database that is revised continuously. Changes to the list of sampled cables are based on the results of the measurements and visual inspections.

SNSA position: There are no further requirements for this issue.

2.3. Concealed pipework

2.3.1. Finding n°1: **TD-2Z program improvement**

Technical implementing procedures for detection of ageing effects are not included in the TD-2Z "Buried and underground piping and tanks" program, although they should be developed and described in the program. Provisionally, that kind of procedures are provided by external contractors, which perform inspections. These contractor procedures are checked and approved by the Krško NPP. The Krško NPP is therefore obliged to include the implementing procedures in the next revision of the TD-2Z program.

2.3.2. Country position and action on finding n°1 (licensee, regulator, justification)

Current status in the Krško NPP: A new revision (rev. 4) of the TD-2Z program was issued in October 2017. It includes the needed technical implementing procedures developed by Krško NPP, including some procedures developed by contractors that provide guided wave ultrasonic inspections and magnetic flux leakage inspections.

SNSA position: This issue is solved, and no further actions are required.

2.4. Reactor pressure vessel

There were no findings identified from the self-assessment on reactor pressure vessel subject.

2.5. Concrete containment structure and pre-stressed concrete pressure vessel

2.5.1. Finding n°1: **TD-2N program improvement**

It is recognized that the Krško NPP should improve the coordination and complete overview over the work of external contracted organizations. Generally, the Krško NPP reviews all implementation procedures of the contractors, and also the results of their activities, but does not always have enough time and resources to examine and supervise their work in detail.

2.5.2. Country position and action on finding n°1 (licensee, regulator, justification)

Current status in the Krško NPP: Krško NPP prepared a new revision of the TD-2N program in August 2018, where the types and contents of technical procedures, that are carried out by external contractors are stated. Apart from that, it is stated that these procedures must not only be in accordance with the TD-2N program and with administrative and technical procedures of the Krško NPP but must be approved by the Krško NPP's staff as well in order to have bether supervision of external contractors' procedures and activities.

SNSA position: There are no further requirements for this issue.

3. COUNTRY SPECIFIC FINDINGS RESULTING FROM THE TPR

There were no country specific findings resulting from the TPR for Slovenia.

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: **Adressed**

4.1.2. Country planned action if relevant

Current status in the Krško NPP: Krško NPP has a lot of aged spare cables in trays and they can be taken out for testing as needed. In addition, a lot of removed cables from different plant buildings are continuously stored for future testing purposes.

In the next revision of procedure ADP-1.4.459, use of non-functional (spare) cables samples for field or laboratory testing will be explained (31.12.2020 – Table: Summary of the planned actions).

SNSA position: Most of the countries use one (cable deposit) or the other approach (representative cable samples). This approach shall also be formalized in procedures. Such samples could be used in future in laboratories testing. With the results the deeper insights of cable condition will be obtained. Additionally, the Krško NPP already has cable samples in warehouse, but those samples are aged under normal conditions and not under operating conditions inside the containment and other technical part of NPP. Consequently, the results from testing of such samples would be different and not representative.

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: **Adressed**

4.2.2. Country planned action if relevant

Current status in the Krško NPP: Documentation of the cable AMP in Krško NPP is visible through: procedures, databases eBS, PM, CAP, COMSY, with results reports (test, inspections, record and monitor characteristics), operating experience. No action required.

SNSA position: It shall be verified that calculations, investigations and type-test exist for the Krško NPP cables. It shall be verified that all documentation and database (eBS, PM, CAP, Comsy, EQ) is complete and traceable (e.g. identification number, manufacturer documentations, actions, operating experience).

Above investigation will be carried out during inspection in Krško NPP.

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: **Adressed**

4.3.2. Country planned action if relevant

Current status in the Krško NPP: This issue is adressed in Krško NPP. Methods to collect cable ageing and performance data are implemented.

SNSA position: This issue is closed.

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: **Adressed**

4.4.2. Country planned action if relevant

Current status in the Krško NPP: In the CAMP program all degradation mechanisms and stressors come from GALL documents.

Krško NPP also closely follows international practice and reviews additional documents within its Operating Experience Assessment Program. If any additional degradation mechanisms or stressors could be applicable for the plant, they would be evaluated in CAP.

Additionally, Krško NPP representatives, are members and active contributors of international organizations dealing with the cable aging: IAEA, EPRI, IEEE. Since 2001 Krško NPP representatives have been participating on EPRI Cable Users Group, where also Krško NPP experiences have been presented. Since 2017 Krško NPP is member of Steering Committee of CUG where is in position to suggest other investigations evaluated by EPRI. Since 2015 Krško NPP is following and from 2017 participating as co-author of IGALL that includes all international practice on cable aging.

Krško NPP also conduct our own research cable test for specific cable types, environment and testing methods acceptance criteria. No action required.

SNSA position: This issue is fulfilled. SNSA will check if EQ test reports for cables consider all mechanisms and stressors.

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 minimised, either by removing stressors contributing to its growth or by detecting degradation by applying appropriate methods and related criteria.

4.5.1. Country implementation: **Adressed**

4.5.2. Country planned action if relevant

Current status in the Krško NPP: This issue is adressed in the Krško NPP.

The cables in Krško NPP have been submerged in the past. Now Krško has solved the problem so that the cabeles are no longer submerged and they also have steps in procedures to ensure that cables will not be not submerged in the future.

SNSA position: This issue is closed.

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: **Adressed**

4.6.2. Country planned action if relevant

Current status in the Krško NPP: This issue is applicable for Krško NPP.

Krško NPP will review the suggested documents: IAEA NP-T-3.6 (2012), Sandia Report 2013-2388 (2013) and IGALL TLAA-201.

Based on the review results the required actions for improvements will be identified. The review will be part of PSR 3 review process (31.12.2022 - Table: Summary of the planned actions).

SNSA position: From EQ uncertainties point of view, Krško NPP shall review the following documents: IAEA NP-T-3.6 (2012), Sandia Report 2013-2388 (2013) and IGALL TLAA-201 as a part of PSR3.

The Krško NPP should verify EQ cables reports, because of the stressors uncertainties and assess if EQ cables reports are still representative.

Based on this review the Krško NPP shall identify needed actions for improvements and report to the SNSA.

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: **Adressed**

4.7.2. Country planned action if relevant

Current status in the Krško NPP: In the last years, the Krško NPP implemented several modifications, where SSC are designed for DEC. Krško NPP shall consider DEC requirements also for newly installed cables in the future (Continuous action - Table: Summary of the planned actions).

SNSA position: SNSA will review through inspection, that DEC cables are qualified for highest stressors.

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: **Adressed**

4.8.2. Country planned action if relevant

Current status in the Krško NPP: This issue is adressed in the Krško NPP. Relevant techniques to detect the degradation of inaccessible cables are implemented.

SNSA position: This issue is closed.

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: **Good practice**
5.1.1.2. Country position

Current status in the Krško NPP: This GP is implemented in NEK. In year 2017 OSART-LTO mission was implemented in NEK.

Krško NPP and SNSA shall strive to maintain this good practice.

SNSA position: Ageing management methodology, which is in general similar to the IAEA standards and guidelines, was confirmed with conclusions of the OSART-LTO module carried out in the Krško NPP in 2017. Additionally, SNSA examines possibilities and scope to invite SALTO mission to the Krško NPP before 2023.

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.

Generic finding has not been considered for Slovenia, based on the ENSREG TPR country specific report.

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

Current status in the Krško NPP: Krško NPP AMP program is prepared in accordance with US NRC GALL report. Currently AMP program does not follow IAEA documents (e.g. iGALL, NS-G-2.12…).

The review of NEK AMP will be part of next Periodic Safety Review number 3. It is planned that review, from the perspective of IAEA SSG 48 requirements, will be part of this review (31.12.2022 - Table: Summary of the planned actions).

SNSA position: Krško NPP shall review the new IAEA Safety Standard SSG 48 "Ageing Managemnt and Development of a Programme for Long Term Operation of NPP" and verify that Krško NPP AMP program is in compliance with the standard as a part of PSR3. In case of incompliances, AMP program shall be updated.

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

Current status in the Krško NPP: Krško NPP is operating for more than 30 years without any significant shutdowns, except regular outages or short shutdowns due to maintenance reasons. So far, Krško NPP hasn't had an extended shutdown. Also, Krško NPP doesn't plan any extended shutdowns in the future. In case the extended shutdown occurs, Krško NPP will prepare appropriate measures to control aging and other effects.

Legislation currently addresses only aging during operating lifetime. Requirements in Nuclear Safety Act is as follows:

"The operator of a radiation or nuclear facility must ensure in the operating lifetime of a facility to monitor the process of aging of the equipment and implement the measures to reduce or eliminate the effects of these processes."

The definition of operating lifetime in our legislation is:

"Operating lifetime of a facility shall mean the period during which a facility is to be used for the planned purpose."

Action is for the SNSA. The Krško NPP does not plan to perform any advance action for potential long term extended shutdowns, since there is not unique program that could answer so many unknowns for such event. However, The Krško NPP will follow all industrial practices and development of programs for such potential plant conditions.

SNSA position: The SNSA will review the legislation whether this type of nuclear lifecycle phase is covered and if needed the legislation will be amended (31.12.2020 - Table: Summary of the planned actions).

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.

Generic finding has not been considered for Slovenia, based on the ENSREG TPR country specific report.

5.2. Concealed pipework

5.2.1. Good practice: use of results from regular monitoring of the condition of civil structures

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: **Not concerned**

5.2.1.2. Country position

Current status in the Krško NPP: Krško NPP currently does not explicitly address the results of monitoring of the condition of civil structures to be used as input to the ageing management programme

for concealed pipework (TD-2Z). However, it periodically monitors the condition of civil structures such as the concrete shield building, but according to the results of such a monitoring, there has been no need so far to take any action with regard to the concealed pipework.

Within the Operating Experience Assessment Program, the Krško NPP will continue to observe the practices of others from the industry around the world.

The Krško NPP settlements are measured twice a year (spring, autumn). The Krško NPP long-term results show that the impact of settlements on the underground pipelines is negligible.

However, if the settlements increase significantly then the analysis in Corrective Action Program (CAP) is initiated and between others also the TD-2Z program for concealed pipeworks would be addressed.

No action required.

SNSA position: Krško NPP shall observe the practices of others and consider their implementation through its Operating Experience Assessment Program, if applicable. Other than that, due to local history and results of observations (i.e. amount of settlement of civil structures during the life of the plant), there are no regulatory requirements for this particular action at the moment.

5.2.2. Good practice: performance checks for new or novel materials

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: **Not concerned**

5.2.2.2. Country position

Current status in the Krško NPP: Concealed pipework in the Krško NPP that is subjected to the ageing management programme is made of steel. There is currently no need to swap portions of such pipework with pipes made of other material. Portions of the buried fire protection system pipes are made of HDPE and are fully backfilled using controlled low strength material. According to NUREG-1801, Rev. 2, XI.M41, no inspection is necessary for such portions.

In fact, only material with good operating experiences (OEs) can be selected for Krško NPP design purposes.

The proposed good practice has a sense in case of new or novel material with lack of OEs or even with the bad OEs. However, such material selection shall be avoided in the design stage. AMP is based on OEs worldwide not only on plant specific OEs.

No action is required.

SNSA position: There are no regulatory requirements for this particular action.

If any new or novel materials with a lack of OEs are used or planned to be used, e.g. in a hypothetical case, where no proven material with good OEs would be applicable, it should be included in the AMP in accordance with this good practice.

5.2.3. TPR expected level of performance: inspection of safety-related pipework penetrations

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

Current status in the Krško NPP: Ageing management programme for concealed pipework in the Krško NPP (programme TD-2Z) does not exclude penetrations through concrete structures. However, some inspection methods used on the portions of the pipe sections embedded in the concrete may provide only limited results.

As a response to the »Area for Improvement«, the Krško NPP has investigated possibilities to inspect safety-related pipework penetrations through concrete structures by guided wave ultrasonic inspection (GW UT). This is very feasible inspection that will detect potential corrosion damages (if they exist) on the portion of pipes running through concrete penetrations. By reevaluation of GW UT data from year 2009 inspection, performed on NPP Krško service water (SW) pipework system, it was found out that on the one of the SW line data was acquired also for the pipe within concrete structure penetration. Data quality was high, and evaluation resulted with "No degradation" conclusion.

All subjected pipework is configured in such way that the pipe is not in direct contact with concrete building wall. The gap between pipe and concrete is filled with special rubber sealing, that has no influence on ultrasonic attenuation, so it can be expected that the quality of obtained data will allow evaluation of pipework condition within penetration. For this inspection, the thermal insulation close to the wall penetrations shall be dismounted in SW and component cooling (CC) buildings, and UT probes will be placed as closed as possible to the concrete walls. Additionally, it will be performed complementary visual examination by insertion of video endoscope probe in to the gaps between pipe outside surface, and concrete penetration itself. NPP Krško is planning to perform this inspection at latest during the Outage 2019 and inspection results evaluation (31.3.2020 - Table: Summary of the planned actions).

SNSA position: Krško NPP has already put the inspection of the penetrations through concrete structures by ultrasonic guide waves on the action schedule for the Outage 2019, which should be completed by the end of October 2019. This inspection will be monitored by a relevant technical support organization as well. After the processing of the gathered data, SNSA expects the Krško NPP to conduct a proper analysis and to present the final results of the inspection with potential further actions no later than 31 March 2020.

5.2.4. TPR expected level of performance: scope of concealed pipework included in AMPs

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

Current status in the Krško NPP: Krško NPP's buried and underground piping and tanks programme includes each underground pipeline or tank that is classified as code class/safety-related or contains hazardous materials and is constructed from a material susceptible to degradation. All piping and tanks fulfilling those criteria have to be appropriately examined under the Krško NPP's AMP. Example: fire protection systems underground piping is included in the AMP programme, although this pipework is generally non-safety related.

SNSA position: There are no further regulatory requirements for this area. All the concealed pipework made of steel are covered by the AMP programme.

5.2.5. TPR expected level of performance: opportunistic inspections

Opportunistic inspection of concealed pipework is undertaken whenever the pipework becomes accessible for other purposes.

5.2.5.1. Allocation by the TPR: **Good performance**

5.2.5.2. Country position and action

Current status in the Krško NPP: The Krško NPP's programme TD-2Z, "Buried and Underground Piping and Tanks", Rev.4, requires two types of inspections to be performed for detection of aging effects in concealed

pipework, one of them being the opportunistic inspection (as opposed to the direct inspection). According to the TD-2Z programme, opportunistic inspections, such as visual testing, shall be undertaken whenever buried or underground components become accessible for any reason (excavation).

SNSA position: There are no further regulatory requirements for this area, since opportunistic inspections of the concealed pipework are included in and required by the AMP programme.

5.3. Reactor pressure vessel

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

Current status in the Krško NPP: The hydrogen water chemisty is used in the Krško NPP from the beginning of operation. The hydrogen is added to the RCS in order to establish reductive conditions in the primary coolant to prevent corrosion.

SNSA position: No additional requirements.

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: **/**
5.3.2.2. Country position

Current status in the Krško NPP: In the Krško NPP the so called "low leakage loading pattern" of reactor core loading is implemented from 5th nuclear fuel cycle onwards to preventively reduce the neutron flux on the RPV wall.

SNSA position: No additional requirements.

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.

Generic finding has not been considered for Slovenia, based on the ENSREG TPR country specific report.

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: **Area for improvement**
5.3.4.2. Country position and action

Current status in the Krško NPP: The Krško NPP In-service Inspection (ISI) includes the non-destructive examinations of reactor pressure vessel welds and pressure retaining bolting. The ISI program

employs different methods for non-destructive examinations of reactor pressure vessel, as prescribed in ASME XI, such as visual examinations, magnetic particle examination, liquid penetrant examinations, eddy current examination for detection of surface flaws, volumetric examination, ultrasonic examination.

The Krško NPP performed comprehensive review of manufacturing and inspection records for possibility of hydrogen flakes in the base material of reactor pressure vessel as part of the monitoring of operational experiences in nuclear industry and according to the WENRA recommendations. The Krško NPP RPV base material in beltline region is made from rolled plates SA 533 Grade B, Class 1 and therefore is not susceptible to "Quasi-Laminar RPV Indications in base material in beltline region as found in Doel 3, Tihange 2 and Beznau 1". This conclusion is based on USA nuclear industry studies accepted by US NRC. Having in mind that the Krško NPP has SA-533 RPV base material in beltline region, there is no technical basis for additional inspections requirements. Manufacturer of RPV was Combustion Engineering with subcontractors (e.g. Lukes Steel Company, USA for Rolled Steel Plates). Pre-service inspection did not detect appearance of hydrogen flakes in the base material of the reactor pressure vessel for prescribed scope.

Slovenian Nuclear Authorities addressed this issue couple of times and all discussions were closed without any open question.

Additionally, in 2013, the Krško NPP carried out a preventive inspection of the RPV calibration blocks using the UT method. No indications found.

SNSA position: The Krško NPP shall follow the relevant operational experiences regarding NDE in the base-material of beltline region in order to detect defects (OEF area).

The Krško NPP shall follow the current state of the art of the NDE in the base material of beltline region. Based on feasibility study/analysis of using new NDE techniques the improvements of existing NDE should be implemented (R&D area) (Continuous action - Table: Summary of the planned actions).

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.

Generic finding has not been considered for Slovenia, based on the ENSREG TPR country specific report.

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.

Generic finding has not been considered for Slovenia, based on the ENSREG TPR country specific report.

5.4. Concrete containment structure and pre-stressed concrete pressure vessel

5.4.1. Good practice: monitoring of concrete structures

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: /

5.4.1.2. Country position

Current status in the Krško NPP: There are no sensors in the concrete structure of the containment of the Krško NPP, partially because it represents only a concrete shield building and not the containment itself

(which is made of steel). However, the Krško NPP corrective action program complies with 10CFR50, Appendix B and it ensures that, inter alia, the need to use complementary instruments is timely analyzed.

SNSA position: Visual methods used on the shield building to monitor the consequences of mechanical behaviour (settlement, cracking) so far proved sufficient. Due to concurrent results of such a monitoring, there are no urgent requests to include instrumentation such as strain sensors into the shield building walls.

No action required.

5.4.2. Good practice: assessment of inaccessible and/or limited access structures

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: /

5.4.2.2. Country position

Current status in the Krško NPP: Krško NPP has already started systematically with the material sampling of concrete structures (since 2016). The required tests are performed in an accredited laboratory by the contractor. Reactor building concrete samples are taken on occasion when maintenance work or modifications are being implemented, involving the concrete structures.

Additionally, Krško NPP performs ground water chemistry analysis (twice a year). The ananlysis contains an assessment on the impact of any changes in ground water chemistry (chlorides, sulfates) on below grade concrete structures. Assessment verifies that there are no harmful changes which could lead to concrete degradation.

The Krško NPP will be further following the R&D on NDE. The Krško NPP will include in program TD-2N a section which will address a non-destructive examination (NDE) of inaccessible parts of the shield building structure (31.12.2020 – Table: Summary of the planned actions).

SNSA position: Sampling of material in structures with limited access is prescribed in the Structures Monitoring Programme (TD-2N) and no further requirements are recognized so far.

However, the Krško NPP have been advised by the SNSA to assess the possibility of applying means for non-destructive examination (NDE) of inaccessible parts of the shield building structure.

5.4.3. TPR expected level of performance: monitoring of pre-stressing forces

Pre-stressing forces are monitored on a periodic basis to ensure the containment fulfils its safety function.

Generic finding has not been considered for Slovenia, based on the ENSREG TPR country specific report.

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 (fuel cycle facilities, installations under decommissioning, waste facilities, etc.)

Currently there are no other risk significant nuclear installations in Slovenia.

7. TABLE: SUMMARY OF THE PLANNED ACTIONS

Installation	Thematics	Finding	Planned action	Deadline	Regulator's Approach to Monitoring
Krško NPP	Electrical cables	**GP: 6.1 Characterize the state of the degradation of cables aged at the plant:** Cables are aged within the actual power plant environmental and tested to assess cable condition and determine residual lifetime. From TPR reports it is visible that 8 countries used cable deposit and 6 countries used representative cable samples	In the next revision of procedure ADP-1.4.459, use of non-functional (spare) cables samples for field or laboratory testing will be explained.	31.12.2020	Electrical cables testing will be major subject of the thematic inspection on electrical cables carried out by the SNSA.
Krško NPP	Electrical cables	**AFI: 6.1 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.	The SNSA will carried out inspections on Krško NPP documentation to check if all AMP requirements are satisfied.	31.12.2020	Thematic inspection on electrical cables will be carried out by the SNSA.
Krško NPP	Electrical cables	**AFI: 6.5 Consideration of uncertainties in the initial EQ:**	Krško NPP will review the suggested documents: IAEA NP-T-3.6 (2012), Sandia Report 2013-2388 (2013) and IGALL TLAA-	31.12.2022	Thematic inspection on electrical cables will be carried out by the SNSA.

		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.	201. Based on the review results the required actions for improvements will be identified. The review will be part of thematic inspection.		
Krško NPP	Electrical cables	**AFI: 6.6 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.	Krško NPP shall consider DEC requirements also for newly installed cables in the future.	Cont.	Thematic inspection of electrical cables will be carried out by the SNSA (cables EQ test reports regarding to harsh parameter will be reviewed).
Krško NPP	OAMP	**AFI: 2.1 Methodology for scoping the SSCs subject to ageing management**: The scope of the OAMP is reviewed and, if necessary, updated, in line with the new IAEA Safety Standard after its publication.	The review of NEK AMP will be part of next Periodic Safety Review number 3. It is planned, that also the review from the perspective of IAEA SSG 48 requirements will be performed in the scope of this review.	31.12.2022	SNSA will review and approve safety factor on ageing report within PSR3 activities.
Krško NPP	OAMP	**AFI: 2.2 Delayed NPP projects and extended shutdown:** During long construction	The SNSA will review the legislation whether this type of nuclear lifecycle phase is covered and if needed the legislation will be amended.	31.12.2020	SNSA will inform the Krško NPP, if the legislation is to be amended.

		periods or extended shutdown of NPPs, relevant ageing mechanisms are identified, and appropriate measures are implemented to control any incipient ageing or other effects.			
Krško NPP	Concealed pipework	**AFI: 3.1 Inspection of safety-related pipework penetrations:** 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.	As a response to the "Area for Improvement", NEK has investigated possibilities to inspect safety-related pipework penetrations through concrete structures by guided wave ultrasonic inspection (GW UT). This is very feasible inspection that will detect potential corrosion damages (if they exist) on the portion of pipes running through concrete penetrations. By reevaluation of GW UT data from year 2009 inspection, performed on NPP Krško SW pipework system, it was found out that on the one of the SW line data was acquired also for the pipe within concrete structure penetration. Data quality was high, and evaluation resulted with "No degradation" conclusion. All subjected pipework is configured in such way that the pipe is not in direct contact with concrete building wall. The gap between pipe and concrete is filled with special rubber sealing, that has no influence on ultrasonic attenuation, so it can be expected that the quality of obtained data will allow evaluation of pipework condition within penetration. For this inspection, the thermal insulation close to the wall penetrations shall be dismounted in SW and CC buildings, and UT probes will be	31.3.2020	Krško NPP has already put the inspection of the penetrations through concrete structures by ultrasonic guide waves on the action schedule for the Outage 2019, which should be completed by the end of October 2019. This inspection will be monitored by a relevant technical support organization as well. After the processing of the gathered data, SNSA expects the Krško NPP to conduct a proper analysis and to present the final results of the inspection with potential further actions.

			placed as closed as possible to the concrete walls. Additionally, it will be performed complementary visual examination by insertion of video endoscope probe in to the gaps between pipe outside surface, and concrete penetration itself. NPP Krško is planning to perform this inspection at latest during the Outage 2019 and inspection results eavaluation.		
Krško NPP	Reactor pressure vessel	**AFI: 4.1 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	The Krško NPP shall follow the relevant operational experiences regarding NDE in the base-material of beltline region in order to detect defects (OEF area). The Krško NPP shall follow the current state of the art of the NDE in the base material of beltline region. Based on feasibility study/analysis of using new NDE techniques the improvements of existing NDE should be implemented (R&D area).	Cont.	Thematic inspection on reactor pressure vessel with special attention on relevant OEF and latest R&D regarding comprehensive NDE in the base-material of beltline region will be carried out by the SNSA.
Krško NPP	Concrete containment structure	**GP: 5.2 Assessment of inaccessible and/or limited access structures:** A proactive and comprehensive methodology is implemented to inspect, monitor and assess inaccessible structures or structures with limited access	The Krško NPP will be following the further R&D on a non-destructive examination (NDE). The Krško NPP will include a section which will address NDE of inaccessible parts of the shield building structure in the program TD-2N.	31.12.2020	SNSA will review new revision of the program TD 2N. Follow up thematic inspection on safety related concrete structures will be also carried out by the SNSA covering concrete containment shield building.

8. REFERENCES

[1] HLG_r(2018-37)_422 1st Topical Peer Review Report, October 2018

[2] HLG_r(2018-37)_423 1st TPR country findings, October 2018

[3] Slovenian Technical Review Report on the Krško NPP Ageing Management Program, December 2017

9. ATTACHMENT 1: GENERIC CHALLENGES

Challenges are common to many or all countries and are areas where action at a European level could help to increase available knowledge or drive consistency or produce beneficial new techniques or technology to assist in specific aspects of ageing management.
As it is stated in the final ENSREG TPR report, challenges identified by the peer review are Europe-wide and difficult to resolve for individual countries. The Board also recommends the ENSREG to ask the WENRA to address identified challenges in collaboration with ETSON when applicable.
Although challenges are not ment to be in the NAcP (European level), we took them under consideration and all challenges are therefore addressed in this attachment.

9.1. Overall Ageing Management Programmes (OAMPs)

9.1.1. 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.

9.1.1.1. Allocation by the TPR: **Challenge**
9.1.1.2. Country position

Current status in the Krško NPP: Slovenian legislation already includes requirement that indicators for nuclear facility should cover maintenance including aging. All indicators should have definition and procedure for evaluation based on international practice.

Krško NPP started with AMP more than 10 years ago. In some areas the AMP is very well developed and mature, but in other it is still under development. One of such areas is also indicators. One of the reasons is lack of international practice. Krško NPP itself already has indicators, but those should be compared to the international practice when the international practice will be available. According to plant specific umbrella AMP program, the review of overall AMP including performance indicators is performed every 5 years. Additionally, the Krško NPP performs Periodic Safety Reviews, where AMP is part of that review as a standard topic.

NEK will follow industry experience and development of performance indicators in AMP area. There is no specific action determined except periodic update from the industry.

SNSA position: Krško NPP has already developed two indicators regarding aging: "Number of AMP related corrective actions" and "Overall AMP performance".

These indicators shall be compared to the international practice and supplemented if needed.

9.2. Concealed pipework

9.2.1. Non-invasive inspection methods for long lengths or complex geometries:

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.

9.2.1.1. Allocation by the TPR: **Challenge**
9.2.1.2. Country position

Current status in the Krško NPP: Krško NPP does not develop non-invasive inspection methods but follows the new development available in the industry. Ultrasonic or magnetic flux leakage methods are used as non-destructive volumetric methods for pipeline/tanks inspections. Pipes that are partially excavated and cleaned are examined using conventional ultrasonic examination or long range guided ultrasonic examination. Magnetic flux leakage examination is used particularly for the Diesel Oil tanks.

GW UT method is very usable as screening method for long pipework length segments and gives good results within examination range capable for detecting defects whose cross-sectional areas are at least 2-3% of the total cross-sectional area of the pipe wall. If the indication of degradation is found, additional conventional UT examination should be performed in order to characterize the damage.

Today, there are a number of specific studies prepared, evaluating the feasibility of GW UT method especially for buried piping. The most important ones prepared by Electric Power Research Institute are:

- Torsional Guided Wave Examination of Buried Piping, February 2002
- Further Developments of Guided Wave Examination Application — 2009 Status Report
- Buried Pipe Structural Health Monitoring; Periodic Monitoring Using Permanently Attached Sensors, 2012
- Buried Pipe Guided Wave Examination Reference Document, 2009
- Obtaining Credit for Guided Wave as a Buried Pipe Direct Examination, 2013
- Development of Usage Criteria Opens Door for Guided Wave Technology, Saving Excavation Costs at Nuclear Plants, 2014

Guided wave testing methodology for basic pipes has been qualified by German TÜV SÜD according to EN 14748:2004, Methodology for qualification of non-destructive tests, and for this was issued a certificate in 2010. In the recent years, GW UT has been standardized in Italy (UNI/TS 11317 Non-destructive testing inspection of aboveground pipelines and plant piping using long range guided waves with axial propagation), as well as in Japan (JIS – NDIS 2427). ASTM and BSI are working on definition "standard practice" of guided waves.

American Society for Non-destructive Testing has recognized guided wave testing as a new method by establishing minimum hours for training of NDE personnel and is preparing the training material for it.

The US NRC position is that, even it is not yet qualified in USA (it is just a question of time), it is used in an effective manner as a screening tool, and NRC encourages NPP plants to use the GW UT for the purpose of determining those piping locations that should be inspected, but may not be substituted for the direct inspections (for ex. VT or conventional UT thickness measurements). NPP Krško is at the moment performing the combination of outside VT and GW UT.

The Magnetic flux leakage (MFL) is also method that was employed in NPP Krško, to detect external corrosion damages. Specifically, it was used on examination of diesel oil tanks. With this method, both DO tanks were efficiently examined from the inside, because the outside wall surface is not accessible for direct examination without excavation. The MFL is standardized in ASME Sec. V, Article 16, and it is widely used in petrochemical industry for detection of corrosion degradations on oil tanks. Before the examination, NPP Krško prescribed what sizes of artificial discontinuities shall be reliably detected, as well as other parameters related to the method verification demonstration. For this purpose, it was built a specimen with artificial discontinuities, and after successful demonstration, the examination was performed on real components.

SNSA position: Krško NPP specified the references that prove feasibility of each non-invasive method that is used in the Krško NPP for wall thickness/corrosion measurement. SNSA recognize, that these methods are covered by relevant institutions and standards and are therefore proven and adapted for industrial use. As the Krško NPP does not conduct its own research and development of such methods, but rather implements the standardized ones, both the Krško NPP and SNSA shall continue to follow the development of methods and standards in this area and potentially take appropriate actions, if needed.

9.3. Reactor pressure vessel

9.3.1. State of the art and qualified techniques for NDE:

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 RPV inspections could be improved by establishing and maintaining an up to date European catalogue of state-of-the-art new techniques and technologies for NDE.

9.3.1.1. Allocation by the TPR: Challenge

9.3.1.2. Country position

Current status in the Krško NPP: The ISI program for fourth inspection interval as required by Krško NPP Technical Specification SR 3.0.5 is based on the requirements of the 2007 Edition with the 2008 Addenda of ASME XI, referenced in paragraph (b) of the 10 CFR Part 50.55a in June 2011. The duration of an inservice inspection interval is 10 years.

Ultrasonic examination (UT) of RPV welds, bolts and other critical areas shell be performed in accordance with ASME XI, Appendix I that provides standards for UT implementation related to inspection items. Reactor vessel main welds and bolts requiring UT shall be examined per mandatory ASME XI, Appendix VIII. Krško NPP follows Appendix VIII as implemented by the industry Performed Demonstration Initiative; EPRI PDI Program (Appendix VIII as implemented by the industry Performance Demonstration Initiative - EPRI proprietary) for ultrasonic examination systems. The examinations are based also upon current knowledge and experience on similar examination programs, in-depth design information, good engineering practice and state of the art qualified techniques implementation.

To implement state of the art qualified techniques Krško NPP employs special tool to perform required ultrasonic, eddy current and visual examinations according to the ASME Code Section XI in submerged underwater environment including the RPV circumferential welds, nozzle dissimilar metal welds, nozzle safe-end pipe welds, core area and nozzle inner radius sections of RPV. The ultrasonic system is employed to record, enhance and analyze ultrasonic data while visual system is used for visual examination and video signal and tool coordinate processing. UT system is fully integrated with RPV-ISI Tool to record all the examination data and assess indications. The ISI Tool is equipped to change out End Effectors (EE) with ultrasonic probes and eddy current probes as well as EE with video cameras, through a docking system.

Krško NPP is a member of EPRI NDE Program that includes demonstration and qualification processes for NDE personnel, procedure and equipment. Krško NPP benefits this membership to perform qualification based on ASME Section XI, Mandatory Appendix VIII (performance demonstration for ultrasonic examination systems) with limitations defined by 10 CFR 50.55a.

Krško NPP systematically evaluate operation experiences (OE) from industry (US NRC, EPRI, PWROG, NEI, WANO, INPO, WENRA ect.) related to NDE inspection of RPV, through Krško NPP Corrective Action Program and actively participate on EPRI annually NDE conferences, PWROG Material Committee, and other.

Krško NPP based on regulatory provisions and good industry practice employs new state of the art qualified techniques (inspection structural weld overlays, inspection of dissimilar metal welds, inspection of J-grove welds on RPV head ect.).

As mentioned before, Krško NPP already systematically follows and evaluates OEs related to NDE inspections of RPV from the industry. Krško NPP ISI program in Appendix 8.1, item 1.7.4 also defines and is open to employ alternative examination method and/or new state of the art qualified techniques.

SNSA position: The Krško NPP shall follow the development of the new European catalogue of the state of the art and qualified techniques for NDE for RPV inspections.

In the scope of the existing ISI program any new qualified techniques for NDE (could be also from the European catalogue) should be evaluated for improvements or implementation.

9.4. Concrete containment structure and pre-stressed concrete pressure vessel

9.4.1. Acceptance criteria for the degradation mechanisms:

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.

9.4.1.1. Allocation by the TPR: Challenge

9.4.1.2. Country position

Current status in the Krško NPP: Krško NPP has established acceptance criteria for the following degradations:

- vertical and horizontal displacements;
- width and depth of the cracks in the concrete;
- carbonization of concrete;
- presence of chlorides and sulphates in groundwater;
- damage and impact of damage on the function of the structure.

The above criteria against which the need for corrective actions is evaluated are quantitative in nature and should ensure that the structure and component intended function(s) are maintained under all current licensing basis design conditions during the period of extended operation.

The Krško NPP constant practice is to follow world-wide operating experiences within its Operating Experience Assessment Program.

No action required.

SNSA position: Certain internal criteria used in the ageing management programme at the Krško NPP are even more stringent than industry standards given criteria. The Krško NPP also carries out systematic material sampling for concrete structures material testing. Therefore, there are no additional requirements in this area, especially because the Krško NPP has no negative experiences so far that would require changes of the methods or acceptance criteria used in the ageing management programme.