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Follow up of ENSREG 1st Topical Peer Review Swedish National Action Plan for Swedish Nuclear Facilities

SSM perspective of the Swedish licensee´s progress with ENSREGS 1st Topical Peer Review, Ageing Management, Swedish National Action Plan.

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Contents

1. Introduction

The European Union's Nuclear Safety Directive 2014/87/EURATOM (NSD) requires the member states to undertake topical peer reviews (TPR) every 6 years with the first starting in 2017. For each review the directive requires the following:

a) a national assessment is performed, based on a specific topic related to nuclear safety of the relevant nuclear installations on their territory;
b) all other Member States, and the Commission as observer, are invited to peer review the national assessment referred to in point (a);
c) appropriate follow-up measures are taken of relevant findings resulting from the peer review process;
d) relevant reports are published on the above mentioned process and its main outcome when results are available.

The member states, acting through the European Nuclear Safety Regulators Group (ENSREG), decided that the topic for the first topical peer review is ageing management.

Sweden has previously submitted the Swedish National Assessment Report (NAR) [1] and the Swedish National Action Plan (NAcP) [2] to ENSREG for the Swedish nuclear power plants in accordance with European Union's Nuclear Safety Directive 2014/87/EURATOM (NSD).

The Swedish licensee have submitted a self-assessment of the current progress of the identified actions in the NAcP [3], [4], [5] and the results of the assessments are reported "as is" in the report. Licensees are:

- Forsmark Kraftgrupp AB, FKA NPP
- OKG AB, Oskarshamns NPP
- Ringhals AB, RAB NPP

Status of Progress of Implementation of Ageing Management Programmes (AMP) to Other Risk Significant Nuclear Installations was incorporated by SSM into the TPR process in January 2021. The Swedish Central Interim Storage Facility for Spent Nuclear Fuel (Clab) submitted their self-assessment accordingly and also submitted an assessment of all generic findings from the TPR process [6]; the information submitted has been included in this status report.

2. Overall Ageing Management Programme

2.1. FKA

2.1.1. Systematic Quality Management of the overall Ageing Management Programme

No key performance indicator

Planned action

Implement key performance indicator for ageing related failures.
Deadline: 2020-12-31

Current progress

Forsmark has implemented key performance index (KPI) for ageing management related issues and failure reports attributed to ageing degradation, KPI Ageing", "to assess the effectiveness of the overall ageing management programme in a systematic manner. "KPI Ageing" measures the number of Corrective Actions linked to aging-related failures in the last 12-month period for Structures, Systems and Components (SSCs) that are included in the defined scope of aging management. The assessment covers the failures that have had a potential safety impact on the function of a system and whether the failure has been processed for root cause analysis in the CAP system with the aim of improving the management of aging. This assessment of reported failures is performed monthly in a technical area group and, if ageing degradation related, listed in the action programme for further processing in the AMP group.
The progress of ageing management related actions managed via the CAP system is monitored and evaluated in the technical area groups and managing decisions are performed in the AMP group, consisting of managers and representative engineering specialists from respective involved departments.
A new maintenance IT tool will be launched in year 2021 and will support development of further dedicated indicators for recorded failures due to ageing related degradation when reporting on repairs and restorations.
Ageing management programmes, including CAP, are implemented according to IAEA standards and will be reviewed and fully assessed by IAEA SALTO review services in 2023.
Further cooperation on ageing management between the Swedish licensees is implemented through a common ageing management development forum. The forum intends to further elaborate on future common key performance index development. The common forum also has a continuous discussion through the Swedish licensees' participation in IAEA - IGALL Phase 5 projects, which includes an update of the present IGALL Safety Report No.82. The updated report will include chapters on the evaluation of the effectiveness of ageing management programmes and associated examples of useful KPIs.

Forsmark considers the action resolved.

2.1.2. TLAA not fully updated

Planned action F3

Complete the work with the remaining TLAA's of Forsmark Unit 3 to be valid for 60 years of operation.

Deadline: 2024-12-31

Current progress
The remaining work to complete the TLAAs covering ageing effects of low-cycle fatigue inclusive of the reactor coolant environment factors for the reactor pressure vessel, internals and primary system for Forsmark Unit 3 is scheduled to commence during year 2021.
The updated TLAAs for low-cycle fatigue will cover the time period up to 60 years of operation.
Since the licensing basis documents contain these TLAAs, they must be updated as a vital part of the periodic safety review (PSR) for Forsmark Unit 3 and will be reviewed and commented on by the regulatory body no later than year 2024.

Forsmark considers this action in progress according to plan.

Planned action
Forsmark will by October 31/2019 present a plan on how to manage identified deficiencies and remaining TLAA's in a timely manner before entering LTO period.
Deadline: 2019-10-31

Current progress
Since the regulatory review in 2019 of the periodic safety review (PSR) for the period of Long Term Operation (LTO) (60 years) for Forsmark Unit 1 & 2, and the subsequent regulatory injunction, Forsmark formed and announced an action plan for managing the specific identified deficiencies which resulted from the regulatory review of the PSR.
The identified deficiencies have resulted in re-work and update of the identified TLAAs for LTO for Unit 1 & 2, in accordance with the regulatory findings. The re-worked and updated TLAAs in question has been re-evaluated and approved by the Regulatory Body (RB) which thereby fulfilled the injunction.
As part of the injunction, the RB further concluded that the methodology for identifying relevant TLAAs was inadequate. The methodology has been revised as part of the action plan and was approved by the regulatory review.
The Environmental Qualification of electrical and I&C components is managed by an AMP which has been further reviewed by the Regulatory Body supervisory programme, which concluded that Forsmark has an environmental qualification process that is appropriate for further work with environmental qualification.
The re-work of TLAAs has also included re-work and update of some TLAAs valid for Forsmark Unit 3, which will enter LTO in 2025. Further work to complete the remaining set of TLAAs for Unit 3 is commenced as scheduled and is due to be completed in 2023 and will be included in the regulatory processing of Unit 3 PSR for LTO.
Updated TLAA documentations for LTO:

- Low-cycle fatigue, including environmental factors. (Unit 1 & 2)
- Irradiation embrittlement of RPVs.
- Manufacturing defects for RPVs.
- Thermal ageing of cast stainless steel.
- Irradiation assisted stress corrosion cracking.
- Fatigue of concrete containment steel linear and penetrations.
- Relaxation of containment pre-stress tendons.
- Fatigue of cranes.

A good example of implementing the results of updated TLAAs for LTO was the results and conclusions of the fatigue analysis, inclusive of environmental factors, of the primary coolant system. The specific results of the analyzes for a T-piece intercoupling between the feedwater system and the shutdown cooling system of Unit 1 demonstrated a

utilization factor beyond the acceptance criteria regarding future period of long-term operation. A balanced assessment of available non-destructive evaluation methods, as compensatory action, resulted in the alternative decision to replace the T-piece intercoupling and thereby re-setting the ageing degradation curve.
A synergy to the fatigue analyzes of the primary coolant systems was also an increased knowledge and awareness of the thermal influence from mass flow in various states of plant operation, further identification of governing points with respect to fatigue and subsequent discussions of operational changes to mitigate future unnecessary transients affecting fatigue utilization.

Forsmark considers the action resolved

2.1.3. Methodology for scoping the SSCs subject to ageing management

Planned action
Fully implement SSG-48 and evaluate the original SR-57 based scoping accordingly. Any discrepancies will be managed in accordance with ongoing routines for managing the scope of AM and LTO in Forsmark.
Deadline: 2020-12-31

Current progress
To further update the scope of Ageing Management, Forsmark has implemented an IAEA SSG-48 defined scoping methodology. Deficits regarding scope setting methodology was identified as an issue by the IAEA pre-SALTO review team in the peer review reported results of year 2019, which prompted a systematic evaluation of the latest IAEA guidance for scoping methodology.
The evaluation of the deficits and the assessment of the new specific guidance (SSG-48) has implied revised definitions of in-scope Structures, Systems and Components (SSCs) according to the revised formulation of in-scope criteria in the new specific guidance. As consequence, the scope setting is currently augmented to include also SSC:s previously out of scope by criteria and definitions in the previous IAEA guidance (SR-57).
To comply with new post Fukushima regulatory requirements for internal and external events, Forsmark has recently designed, constructed and commissioned independent core cooling facilities able to supply all three reactor vessels with cooling water in case of certain deterministic accident scenarios. The SSC:s serving these safety functions as design extension are, by the revised definitions, included in the SSG-48 augmented scope for ageing management.
Forsmark intends to further analyze the augmented scope and to revise the comprehensive review of ageing management and the ageing management programmes to fully cover the re-worked scope of Systems Structures and Components.
As a part of a living ageing management programme, the scope of ageing management will continuously be evaluated and updated during the life of the plant, either due to findings regarding present plant systems structures or components or due to managing of obsolescence or system upgrades, thus securing a living programme for upholding the managing of ageing over time.

Forsmark considers this action resolved.

2.1.4. Delayed NPP projects and extended shutdown

Planned action
Implement the aspect of ageing management due to prolonged shutdowns in the instruction for outage management.

Deadline: 2020-03-31

Current progress
For each in-scope Structure, System and Component or Group of components, there is a review of ageing management performed and documented by the technical area responsible part of the operating organisation in Forsmark. The technical area groups have one constellation for each relevant working area: mechanical, electrical, instrument & control and civil structures. Each technical area group includes relevant knowledge representatives from the line organisation of engineering, maintenance and operations. The documented reviews of the ageing management are continuously kept up to date with current knowledge and experience feedback through the technical area groups. Managing the continuous validity of the ageing management review documentation also includes feedback on changes in operational and environmental conditions. Such change in operational and environmental conditions would include also the ageing degradation consequences of long construction periods or extended shutdown of a system or the entire plant.
To further manage any comprehensive needs of enhanced ageing management actions or introduction of preserving environments as a consequence of prolonged shutdown conditions, the outage management instruction is supplemented with requirements for this specific operational condition.

Forsmark considers the action resolved.

2.2. OKG

The overall AMP in OKG follows the principles described in IAEA SSG 48. For the living ageing management, OKG created a joint organisation, “coordination group-ageing” in order to coordinate the overall ageing management. To assist this group OKG also created several AMP groups divided into concrete, electrical/I&C, mechanical, In-Service-Inspection and obsolescence. All these groups have regular meetings which follow an approved agenda in order to improve the ageing management at OKG.

When OKG started the implementation of the ageing management it was also decided to base the ageing management on the IAEA guides, SSG 48 (former NS-G2.12). OKG also decided that peer reviews by IAEA (SALTO) should be carried out as a tool to make sure that OKG ageing management is in line with the IAEA guides. So far there have been two peer reviews:

Pre-SALTO	2017
expert mission	2019

The issues from these peer reviews are important information in the coming work to improve the ageing management at OKG. All issues are recorded in the CAP system and will be handled either by the LTO project or the line organisation.
OKG must also pay attention to a completely new set of regulations that was communicated to the Swedish nuclear power plants last year and make sure that these requirements are incorporated in the new methods.
As an additional aid in making sure that the new methods are in line with IAEA SSG48, OKG will also perform additional peer reviews as shown below (preliminary)

Q3 2022	pre-SALTO
Q3 2024	SALTO
Q3 2026	follow up SALTO

2.2.1. Systematic Quality Management of the overall Ageing Management Programme

Planned action
In the AM instruction, include an obligatory update every 5 year for all AMPs.

Current progress
According to OKG's overall ageing management the AMP groups are responsible for the AMPs. In June 2020 the instruction for the AMP groups was revised with an additional text describing that the AMPs must at least be updated once every five years.

This task has also been addressed in several meetings in the OKG's joint organization for overall ageing management and will also be followed up during the future meetings.
Deadline: 2019-12-31

OKG considers the action resolved.

2.2.2. Systematic Quality Management of the overall Ageing Management Programme

Planned action
Enlarge the number of KPIs.

Current progress
OKG has one KPI in ageing management, since a couple of years, which is followed up on regular basis every other month. This KPI is based on the amount of fault reports caused by ageing in relation to the total amount of fault reports.
In the beginning of this year a work has been finalized to expand the number of "root causes codes" used in the fault reports when defining the root cause for the fault. This means that ageing related faults have got some additional "root cause codes" such as corrosion as an example.
Since more ageing related "codes" are available the number of KPI:s will also increase, so instead of having one KPI based on ageing related faults in general there will also be KPI:s for type of ageing effects, such as corrosion as an example.

Several attempts have been made in the past few years trying to find additional KPIs to measure the effectiveness of the ageing management. The subject has also been discussed with other Swedish power plants in FORSAMP (a Swedish joint organisation for overall ageing management) as well as with IAEA in an attempt to find a suitable way to measure the effectiveness of ageing management

However, in the beginning of 2021 OKG initiated a pilot study with a method to measure the "programme health" according to a bulletin from NEI. The idea is to measure all programmes (maintenance, ISI, chemistry, etc.) and AMPs to produce a scorecard for each one and use this as a KPI. This new method has also been discussed with the other licensees in Sweden.
Deadline: ~~2020-12-31~~ New plan 2022-12-31

OKG considers this action in progress according to revised time plan.

2.2.3. Use of more Specified Criteria to Define Conditional Acceptance Criteria

Planned action
Improvement of AMPs acceptance criteria if necessary.

Current progress
The AMPs will be revised at least once every five years including updating the acceptance criteria if necessary. They will also be revised in OKGs LTO project 2021-2023 including acceptance criteria. Improvements of acceptance criteria is also included in OKG's living ageing management which purpose is to always look for improvements in the ageing management.
Deadline: 2023-12-31

OKG consider the action to be in progress

2.2.4. Review and Updating of the Overall Ageing Management Programme

Planned action
Review and update of TLAA

Current progress
The updating of TLAAs is an ongoing task and has been going on for a couple of years. According to an injunction, all TLAAs will be revalidated and presented to the regulator in the end of 2021. At the moment OKG are mainly focusing on the area related to fatigue analyses, thus working with the following TLLAs:

TLAA 101 Low-Cycle Fatigue Usage
TLAA 106, Environmentally Assisted Fatigue
TLAA 113 Thermal Stratification
Deadline: 2021-12-31

OKG considers the action to be in progress

2.3. RAB

2.3.1. Systematic Quality Management of the overall Ageing Management

Planned actions
Implement main key performance indicator.
Deadline: 2020-12-31

Current progress
Originally Ringhals planned to measure the number of Corrective Maintenance actions linked to aging-related failures but found that to obtain consistent data would be hard when there are many user of the system. This would also be a reactive way to deal with inherent problems and a more proactive way would also be needed.
Instead Ringhals started to use two other measurements, number of aging-related Licensee event Report (LER)/Production Loss (PL) and Programme Health Assessments. These have been deemed to be more effective and have been chosen by Ringhals to be the main key performance indicators in the field of ageing management.

The analysis of LER/PL started 2020 for Ringhals 3 and 4 but it have been employed for events two years before that. The number of LER/PL have over the last three years slowly reduced. More use will assure consistency of the analyses.
Programme Health assessments corresponding to NEI Programme Health Reporting have been adopted to Swedish standards by the power plants within the ageing management forum FORSAMP. It is a method that is proactive in its form and give a good understanding of what efforts is needed to make the programme more effective. Ringhals begun doing these assessments in 2020, these indicators will be better over time as more assessments are done.
Further cooperation on ageing management between the Swedish licensees is implemented through a common ageing management development forum. The forum intends to further elaborate on future common key performance index development. The common forum also has a continuous discussion through the Swedish licensee's participation in IAEA - IGALL Phase 5 projects, which includes an update of the present IGALL Safety Report No.82. The updated report will include chapters on the evaluation of the effectiveness of ageing management programmes and associated examples of useful KPIs.

Ringhals consider this action resolved.

2.3.2. Review and update of overall Ageing Management Programme

Planned actions
All TLAA's are updated and presented in the PSR for R3 and R4. The PSR was submitted to SSM April 2019.
Extend Ringhals 3 pressurizer shell weld and also Low-Cycle Fatigue TLAA from 50 to 60 years of operation.
Deadline: ~~2020-12-31~~ new plan 2024-12-31

Current progress
The progress in the pressurizer shell weld project is according to plan and preliminary results indicates that it will be possible to validate Ringhals Unit 3 pressurizer for 60 years of operation.
Low Cycle Fatigue analyses, qualifying Spray- and Surgeline for 60 years of operation, were finished and accepted by AIB in November 2020. According to current plan associated documentation will be finalized in 2021.

Action in progress

2.3.3. Methodology for scoping the SSCs subject to ageing management

Planned action
Evaluate the original scoping based on SR-57 with regards to SSG 48. Any discrepancies will be evaluated and managed in accordance with Ringhals ongoing routines for managing the scope.
Deadline: ~~2019-12-31~~ New plan 2021-12-31

Current progress
To fulfill SSG48 Ringhals has included waste management to the scope. The work to sort out the valid SSC have started and will be completed during 2021.
To comply with new post Fukushima regulatory requirements for internal and external events, Ringhals has recently commissioned independent core cooling facilities able to

supply the reactor vessels with cooling water in case of certain deterministic accident scenarios. These safety functions as design extension are parts of the SSG-48 scope.
As a part of a living programme, the scope of ageing management will continuously be evaluated and updated, either due to findings regarding present plant systems structures or components or due to managing of obsolescence or system upgrades, thus securing a living programme for upholding the managing of ageing over time.

Action in progress.

2.4. Regulator's assessment of the overall ageing management programme and conclusions

SSM agrees with the licensees that the actions that are considered to be resolved within the area concerning the overall ageing management programme have been resolved and the remaining actions will be handled by the supervisory programme and the PSR process to ensure they will be completed.

2.5. Overall Ageing Management Programme for Clab

2.5.1. Licensee´s assessment regarding generic findings from the TPR

The generic findings from the TPR assessment regarding Overall Ageing Management Programme requirements and implementation in nuclear power plants where:

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.

SKB position and action: No external peer review has been performed and none is planned.

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.

SKB position and action: Project results and gained knowledge are implemented to benefit activities, future plans or predictions.

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.

SKB position and action: SKBs evaluation of the analysis is that existing management is in accordance with the standard and very few discrepancies are noted. No further action planned.

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.

SKB position and action: N/A

2.5.2. Regulators assessment of the ageing management of the Overall Ageing Management Programme at Clab

Clab has developed their overall Ageing Management Programme based on international guides like IAEA NS-G-2.12, SRS 57. The use of international guidance provides conditions for a comprehensive overall Ageing Management Programme to be developed and is in accordance with SSM requirement on ageing management given in Chapter 5 Section 3 Swedish regulations SSMFS 2008:1. The requirement is performance based with the final goal to ensure the availability of required safety functions throughout the service life of the repository facility.

For Clab all SSCs are classified according to their safety importance in the Safety Analysis Report (SAR). SSC:s included in the SAR as a barrier or that are needed to execute a safety function, direct or indirect, are within the scope of the overall AMP. In addition, Technical Specification (STF) and systems jeopardizing SSC in the AMP are also analysed in order to identify discrepancies from SAR.

Components are grouped based on component type, design, operating environment and operating conditions. Each system has been screened for all components needed to uphold the system function as to nuclear safety. The identified components, with motive, are documented in a system-specific screening report where they are listed and grouped. The AMP group has the responsibility for the AM reports and lists to ensure they are actively updated accordingly.

Based on the systems identified for inclusion in the ageing management programme Clab creates system-specific AMPs. For each AMP, all structures and components included, ageing management analysis is performed considering ageing mechanisms, factors and effects, operational and environmental factors, monitoring and surveillance, acceptance criteria, mitigation, experience and suitable actions and measures. These actions and measures are evaluated by gap analysis in relation to existing mitigation and maintenance programmes. Complementary measures are then suggested, introduced and included in existing programmes and if needed, new programmes are established.

This process is found to correspond to the nine criteria described in the IAEA NS-G-2.12, and with the additional gap analysis, verifying that adequate actions are taken as an acceptable basis for ageing management of the SSC.

Indicators for assessing effectiveness of the ageing management programme are under development by Clab. Work in this area is performed within a joint forum (FORSAMP) that handles generic ageing issues together with the Swedish NPP:s.

SSMs opinion is that quality assurance/management of the overall Ageing Management Programme is important to uphold a proactive approach. In this respect quality assurance/management should for example include administrative control that document implementation, indicators to facilitate evaluation of the overall Ageing Management Programme and a confirmation process to ensure that preventive and corrective actions are adequate and effective. SSM considers that quality assurance/management of the overall Ageing Management Programme can be improved amongst all Swedish licensees.

The overall Ageing Management Programme at Clab has been developed in accordance with the guidelines in IAEA safety report NS-G-2.12. The overall AMP is supported by information from other programmes such as Maintenance, Operation programme, In-service inspection, Chemistry programme and Fire protection programme. Using these programmes a lot of experience is gained from operations as well as external ageing related experience.

For the process of identifying ageing mechanisms Clab uses the collaboration FORSAMP (Forsmark, OKG, Ringhals, SKB) and the gross list that the collaboration has put together. This list is based on IGALL, IAEA Safety Report No 82, NOG report SEP 04-120, documents from EPRI, NUREG 1801 (GALL) and specific technical area reports. The list is grouped in by types of material and divided into three areas for each material: ageing mechanism, ageing factors and ageing effects. Data and information in the list are then adapted to local conditions and environments at Clab. Individual engineers use the list to identify ageing mechanisms and possible consequences when performing ageing analysis, and writing component-specific and system-specific ageing management programmes.

SSM considers the process of using both in-house expertise and external experience in different areas to be an effective approach. The use of purchased expert systems can be valuable for identifying ageing mechanisms but it should not exclude the use of the licensee's own interdisciplinary expertise.

An important attribute in ageing management is the establishment of acceptance criteria for which the need of corrective actions are evaluated. Swedish licensees use the high-level criterion that the SSCs shall maintain their intended function during design basis events and during operating life. SSM considers that this high-level criterion should be more specified for example by a process for calculating specific numerical values to define conditional acceptance criteria to ensure the SSCs intended function. Trending and comparison to quantifiable criteria is performed by Clab in limited numbers but is an area under development.

Programmes for monitoring, testing and inspection are described in system-specific AMP-reports, identified and recommended activities and measures are specified, such as monitoring conditions, inspections and survey of components or structures. The testing of safety, processes and systems is performed according to instructions based on SAR, STF and the ageing management programme. SAR and STF are reviewed and updated due to new or altered radiation safety requirements, plant changes or changes in management and control of importance to radioactive safety. Inspection of mechanical devices are performed in accordance with chapter 3 Swedish regulations SSMFS 2008:13.

According to IAEA NS-G 2.12 measures shall be taken to prevent ageing of SSCs, and if ageing effects are identified there shall be a plan to prevent further degradation. At Clab inspections are performed on SSC regardless if any sign of ageing has occurred or not. This is a precaution in order to, at an early stage, identify any unexpected ageing mechanism, factor or effect. It´s a part of ageing management and everyone working in the plant shall observe and report all unexpected signs of ageing parameters. Operations and maintenance personnel perform visual inspections of a large part of the SSCs with the aim to detect unexpected issues. A more specialized training programme for detecting and reporting ageing parameters is under development, where focus is mainly on maintenance and operations staff.

A systematic assessment of preventive and remedial actions is by SSM considered to be an important feature in ageing management. The assessment should be continuously evaluated and systematically documented.

At Clab every modification, refurbishment or replacement of SSC is reported to the ageing management group, which in turn evaluates the impact on present AMPs. Results and findings from failures, root cause analysis, and projects or technical issues are also evaluated and appropriate preventive/remedial actions are thereafter documented. The evaluations are audited and the AMPs, maintenance system and other affected documents are updated.

Every five years Clab perform a system health analysis on all systems within the scope of ageing management. The analysis is performed by interdisciplinary groups compiled of experts from maintenance, operation, radiology, fire safety and engineering. The results are documented in a system status report where the need for maintenance, engineering, upgrades or refurbishment is described. The assessments are made considering a time frame of 1, 5, 10, and 20 years, and plant end-of-line and the identified actions are prioritised and responsible process and group is addressed.

SSM finds that systematic work with both short and long term time frames demonstrates a mature organisation with regard to ageing management and is an example of a good practice.

Review and update of the overall Ageing Management Programme is for Swedish licensees conducted in a similar manner as for updates of other programmes. Findings from internal audits where experts from NPP and the industry are involved, or external inspections by SSM, are performed and the results are implemented into Clab:s corrective action plan and OPEX database.

Involvement of external organisations for review and updates of the overall Ageing Management Programme is according to SSM important to uphold its validity in the light of experience gained as well as of developments in science and technology. Clab are actively collaborating with the Swedish NPP, IGALL and EPRI in order to gain experience, but have not yet performed any external inspections with IAEA or WANO. SSM are pleased to see this collaboration but are also encouraging Clab to consider external inspections as a means for operating experience and further enhancement of the ageing management programme.

SSM agree with the conclusions of the assessment and actions taken by Clab in order to handle the generic findings for the overall ageing management programmes. The actions will be followed up in the supervisory programme. With regard to Clabs assessment, previous inspections and how modifications in the current regulatory framework are considered, it is SSMs opinion that this follows a well-established methodology for Clab. This methodology covers all operational issues included in the overall Ageing Management Programme.

3. Electrical cables

3.1. FKA

3.1.1. AMP for ageing management of electrical cables

Planned action
A separate AMP for cables and cable system is under process of development and needs to be finalized and implemented.
Deadline: 2020-06-30

Current progress
To target the ageing degradation of electrical cables in a systematic manner, Forsmark performed a survey of the combined sum of existing activities managing electrical cables. The survey performed a comparison of external operational experience of best practice, both national and international. The survey also included an assessed the different methods which electrical cables can be condition monitored by, needed personnel qualifications and required specimen selections and intervals.
As a result of the reported survey on electrical cables, a strategy was formed to address the different identified areas for improvement. Examples of such areas for improvement consisted of the need to form a cable group entity for further development of ageing management programmes, collecting and sharing of knowledge and operational experience.
Since the strategy for electrical cables was formed, Forsmark has developed and implemented an ageing management programme (AMP) for electrical cables. The programme was developed using available information om international best practice, experience described in the IAEA IGALL AMPs, EPRI issued documentation and in cooperation with Ringhals NPP.
The documented AMP for electrical cables summons planned actions encompassing e.g. plans and procedures for one-time inspections, definition of scope for recurring walkdowns, training of personnel and routines for collecting of samples.

Forsmark considers this action resolved.

3.1.2. Appropriate techniques are used to detect degradation of inaccessible cables

Planned action
Forsmark is planning to analyze and test the condition of our 6kV and 10kV cables within the NPP by using available methods, such as Tan Delta and Partial Discharge.
Deadline: ~~2021-12-31~~ New plan 2023-12-31

Current progress
Forsmark formed a plan for a testing campaign to establish condition monitoring parameters for electrical cables. A project has started to handle the cable analyzes and condition monitoring tests that will be performed at Forsmark Unit 1 & 2 for 6kV cables during year 2021-2022.
For Forsmark Unit 3, conditions monitoring tests of 10kV cables are planned to be performed during year 2023 using electrical testing methods combined with walkdowns and visual inspections.

The project plans, implementation and documented results will be monitored and analyzed by the cable group entity as well as the technical area group for electrical systems and components.

Forsmark considers this action in progress according to revised time plan.

3.2. OKG (No actions)

3.3. RAB

3.3.1. Good practice: characterize the state of the degradation of cables aged at the plant

Planned action
Investigate the possibility for making cable deposits.
Deadline: 2019-12-31

Current progress
Cable deposits are to be installed in Ringhals 3 during the outage 2021.

Ringhals consider this action resolved.

3.3.2. TPR expected level of performance: consideration of uncertainties in the initial EQ

Planned actions
To analysis the validity of the activation energies used for cables.
Deadline: 2019-12-31

Current progress
An analysis of the validity of the activation energies for all components is finished. All activation energies for cables were found valid.

Ringhals consider this action resolved.

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

Planned action
Test 6 kV cables inside containment with the VLF Tan/Delta methodology.
Deadline: 2020-12-31

Current progress
The first VLF Tan/Delta tests on 6kV cables where done in 2020 in conjunction with switchgear jobs. No immediate problems where found but the test results will serve as a baseline for future tests.
The rest of the 6kV cables in Ringhals 3 and 4 will be measured during the remaining switchgear jobs until 2025.
The values obtained will indicate the needed intervals for further tests, also opportunistic tests will be done in case these cables are to be disconnected.

Ringhals consider the VLF Tan/Delta tests implemented and this action is thereby resolved.

3.3.4. TPR expected level of performance: determining cables performance under highest stressors

Planned action
Clarify SSC credited in the plant safety analysis for a severe accident in the environmental qualification programme.
Deadline: ~~2020-12-31~~ New-plan 2022-12-31

Current progress
The additional SSC:s which are credited for Severe Accident and planned to be included in the EQ programme are SSC:s belonging to the consequence mitigating systems (360-systems). These systems are designed to handle Severe Accidents and associated environmental conditions. Since they are not safety functions they were not included in the scope for the EQ-programme at start. However, since they are safety related and designed to mitigate Severe Accidents Ringhals plans to include them in the EQ programme. This work remains to be done. A plan for this work will be formed 2021Q3. It can be noted that during 2020 the independent core cooling system (OBH) were installed. This system is situated in a new building designed to keep normal environmental conditions inside even after an initiating event. The OBH is included in the EQ programme. The OBH further reduces the probability for the need to use the consequence mitigating systems.

Action in progress.

3.4. Regulator's assessment and conclusions on ageing management of electrical cables

SSM agrees with the licensees that the actions that are considered to be resolved within the area concerning cables have been resolved and the remaining actions will be handled by the supervisory programme to ensure they will be completed.

3.5. Electrical cables at Clab

3.5.1. Licensee´s assessment regarding generic findings from the TPR

The generic findings from the TPR assessment regarding electrical cables in nuclear power plants where:

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.

SKB position and action: Non-destructive testing of cables important to nuclear safety is preformed regularly by visual inspections and walk-downs. The cables in the harshest environment are taken to represent all other cables of the same type.

TPR expected level of performance: *Documentation of the cable Ageing Management Programme* − The AMP is sufficiently well-documented to support any internal or external reviews in a fully traceable manner.

SKB position and action: Clab has implemented an AMP for cables, and this is based on the principles of IAEA Safety Guide No. NS-G-2.12.

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

SKB position and action: Data and test results are collected and documented.
The results are inputs to the maintenance plan and to the AMP for cables.

TPR expected level of performance: *Systematic identification of ageing degradation mechanisms considering cable* − 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.

SKB position and action: Degradation mechanisms and stressors are listed in the AMP for cables. This list is based on a common gross list of ageing mechanisms.

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.

SKB position and action: The cables with crosslinked polyethylene as insulation/jacket are not used in that type of environment, where water treeing is an issue. If water treeing would occur, Clab have methods to detect it.

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.

SKB position and action: Clab doesn’t have a specific environmental qualification programme for ageing management of cables.

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.

SKB position and action: N/A

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.

SKB position and action: By measuring the cables installation environments and evaluate experiences both internal and external of similar cable types, some problems can be predicted. Some cables are continuously monitored by a closed current circuit, this will only alert that something is wrong but the plant has two safety trains so there is time to

perform an exchange without endangering the plant safety. Closed current circuit for signal cables is just one example of fault detection, other methods are for example when a 4-20 mA transmitter gives 0 mA back, indicating either a problem with the transmitter or the cable.

3.5.2. Regulators assessment of the ageing management of electrical cables at Clab

As licensee for The Swedish interim storage of nuclear fuel, Clab, SKB have develop their overall Ageing Management Programme based on international guides like IAEA NS-G-2.12.

The scope of the Ageing Management Programme of electrical cables used by the Clab covers all cables necessary to maintain high availability of the facility or cables connected to SSCs assigned with safety-functions important to nuclear safety.

Clab doesn't have any cables assigned with electrical function class 1E, and thus no cables with environmental qualification requirements.

No cables have been assigned any security or safety-functions according to Clabs Safety Analysis Report. However, cables are essential for component power supply as well as transfer of signals to achieve high availability of the facility. The cables inherit the connected functions or components assigned safety-function.

Regarding identification of ageing mechanisms related to cables SKB and the three licensees FKA, OKG and RAB have a cooperation within the framework of a FORS-AMPs forum, which has resulted in the establishment of a common gross list of degradation mechanisms for all types of components.

SSMs opinion is that the cooperation between the Swedish utilities is very important to understand and learn more about degradations mechanisms. This will as well support utilities to carry out ageing analysis.

Clab states that the effect (loss of flexibility, hardening, decreased insulation resistance etc.) of ageing mechanisms and detection of different ageing stressors are easier to detect than the detection of ageing mechanisms. Therefore, Clabs AMP mainly focuses on detecting of these different ageing effects and stressors to handle the different ageing mechanisms.

Clab apply that there are a number of different monitoring, testing, sampling and inspection activities for electrical cables at Clab. The various activities used by Clab are only non-destructive methods.

Regarding preventive and remedial actions for electrical cables results are evaluated and analysis are done. If the acceptance criteria are exceeded the preventive maintenance will be reviewed and adjusted. The adjustments will then be documented in the Maintenance system and AMP

SSM assesses that the monitoring, testing, sampling and inspection of the electrical cables are fundamental and very important to give signs and indicate when cables start degrading. This also gives information that can be used to assess the interval and the applicability of preventive actions. SSM believes strongly that the aim of the Ageing

Management Programme is to deal with ageing's issues and not to wait until the cables are degraded and must be replaced through remedial actions

Regarding the licensee´s experience of the application of AMPs for electrical cables Clab continuously updates AMP and other document related to ageing. Changes in the programme can be based on own experiences from for example inspection or external experience from other power plants. SKB is member of Nord-ERF. Nord-ERF is a cooperation between 6 Nordic nuclear facilities that screens events around the world that concerns nuclear safety.

SSMs opinion is that the experience of the application of AMPs for electrical cables is very important to modify the maintenance programme if needed, but also to perform constantly improvement regarding scope, methodology and frequency of existing AMP to ensure fulfilment of the objectives related to AMP.

Based on the description above, SSM concludes that SKB for electrical cables at Clab, has an implemented ageing management programme.

Furthermore, SSM agrees with SKB stated position with respect to the TPR generic findings for the electrical cables at Clab.

4. Concealed pipework

4.1. FKA (No actions)

4.2. OKG

4.2.1. Exchange Information and Experiences

Planned action
Oskarshamn will investigate how further cooperation can be organised.

Current progress
As part of the cooperation within ageing management between the Swedish licensees, the subject of concealed piping is continuously discussed upon opportunity and necessity.

This is to further identify examples in the typical Swedish BWR designs which could implicate the need of ageing management development for buried or underground safety related pipework.

In addition, two of the Swedish licensees, Ringhals and Forsmark, have initiated a joint annual meeting session involving plant engineering and mechanical maintenance staff to specifically discuss any recent operational experience involving concealed pipework. So far one such meeting session has been held and for the next meetings OKG will be invited.

The licensees have also started a common work to develop technical specifications regarding civil structures.

In addition to these forums mentioned above, the Swedish licensees continue drafting and assessing of information from the national and international operating experience and event reports issued by NORDERF, IAEA/Igall, Energiforsk and FORSAMP.
Deadline: 2021-12-31

OKG consider the action to be in progress.

4.2.2. Scope of Concealed Pipework included in AMPs

Planned action
Improvement in definition of non safety affecting safety in the scope of ageing management (NSAS).

Current progress
In the framework of the LTO project a new scope for the ageing management will be developed based on IAEA SSG48 including a method to handle NSAS.
Deadline: 2023-12-31

OKG consider the action to be in progress.

4.3. RAB

4.3.1. Exchange information and experience

Planned action
Ringhals will investigate how further cooperation can be organized.
Deadline: 2019-12-31

Current progress
As part of the cooperation on ageing management between the Swedish licensees, the subject of concealed piping is continuously discussed upon opportunity and necessity. This is to further identify examples in the typical Swedish designs which could implicate needs of ageing management development for buried or underground safety related pipework.
In addition, the Swedish licensees has initiated an joint annual meeting session involving plant engineering and mechanical maintenance staff to specifically discuss any recent operational experience involving concealed pipework. So far one such meeting session has been held.
In addition to these forums mentioned above, the Swedish licensees continuously draft and assess information from the national and international operating experiences and event reports issued by NORDERF, IAEA-IRS, WANO and EC-JRC-Clearinghouse.

Ringhals considers this action resolved.

4.4. Regulator’s assessment and conclusions on ageing management of concealed pipework

SSM agrees with the licensees that the actions that are considered to be resolved within the area concerning concealed pipework have been resolved and the remaining actions

will be handled by the supervisory programme as well as the regulatory review of the PSR in order to ensure they are or will be will be completed.

4.5. Concealed pipework at Clab

4.5.1. Licensee´s assessment regarding generic findings from the TPR

The generic findings from the TPR assessment regarding concealed pipework in nuclear power plants where:

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.

SKB position and action: Clab has not done any significant observations. The reason is that Clab is constructed on solid rock, the buildings are founded on granite.
Plant walkdowns are regularly performed to observe any settling in buildings and pipe suspensions

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.

SKB position and action: SKB uses only proven material according to those given in the technical regulations, TBM. SKB has no plan for this.

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.

SKB position and action: Clab has no safety-pipework penetration. Pipe penetrations are handled by component AMP and in each system AMP.

TPR expected level of performance: S*cope 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.

SKB position and action: Ageing management at Clab includes all safety related SSC. Also including non-safety SSC whose failure my cause damage to SSCs important to safety. When scoping for components within systems or facilities Clab has performed detailed walkdowns to reveal any potential risk factors.

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

SKB position and action: Inspections of this kind is handled in each case. For example, when replacing fire hydrants in the Fire protection system that are directly connected to

the ring line, inspection/NDT is to be done if a larger part of the ring line is exposed. This is done to successfully charter as much of the ring line as possible.

4.5.2. Regulators assessment of the ageing management of concealed pipework at Clab

From the review of SKBs ageing management of concealed pipework at Clab, with the scope set out in this report, SSM has found that

- the scope encompass safety and safety related SSCs in accordance with SSMFS 2008:1 Chapter 1 Section 1
- there are no concealed pipework that contains radioactive effluents or transfers fuel for emergency power generation,
- there are several systems that provide essential service water for cooling of SSCs important to safety that contain concealed pipework;
  - Cooling system (in covered trenches),
  - Emergency make-up water system for storage pools (partly encased in concrete),
  - Fire protection water system (buried in soil) and
  - Distribution system for processed demineralized water (partly in covered trenches).
- material susceptible to ageing has been identified, the functions of each component has been considered and relevant ageing mechanisms identified,
- Concealed pipework are covered by two AMPs, one for pipework and one for penetrations,
- environmental and water chemistry parameters are monitored and used for trending
- deviations from “normal” parameters are evaluated with respect to its potential impact on the rate of degradation of the concealed pipework
- plant walkdown, qualified non-destructive testing and visual inspections (including remote camera inspections) are used to detect ageing effects
- preventive methods are preferred by SKB, but if that is not possible corrective actions are taken. No remedial methods are in use.
- The AMPs and maintenance programme are updated with new experiences when necessary

Based on the description above, SSM concludes that SKB for the concealed pipework at Clab, has an implemented ageing management programme that covers the nine attributes of IAEA:s SSG-48.

Furthermore, SSM agrees with SKB stated position with respect to the TPR generic findings for the concealed pipework at Clab.

5. Reactor Pressure Vessel

5.1. FKA

5.1.1. Environmental effect of the coolant

Planned action
When the unit enters LTO in 2025, the re-evaluated analyses will be in-place.
Deadline: 2024-12-31

Current progress
Further work to complete the remaining set of TLAAs for Unit 3 is commenced and is due to be completed in 2023. The TLAAs will be included in the regulatory processing of the Unit 3 PSR for LTO.

Forsmark considers this action in progress according to plan.
(See part 2.1.2)

5.2. OKG

5.2.1. Surveillance Programme for LTO

Planned action
The surveillance programme will be updated to cover the prolonged operational time (60 years).

Current progress
The review performed by SSM of the surveillance programme was received in December 2020, see SSM2018-3716-7.

SSM agrees to the OKG programme and states that there will be enough material data to cover the RPV-material behavior for operation of the reactor until 2062. However, the authority would like to see an updated programme including intervals and withdrawal years for the external dosimeters (mentioned in the original report), whenever this is available.

OKG is planning to update the surveillance programme with the requested data as soon as we get the results from the first shipment of dosimeters that is planned to leave Sweden in February 2021. OKG estimates that the results will be presented to us in late 2021, whereupon we can deliver an updated surveillance plan to SSM.
Deadline: ~~2019-12-31~~ New plan 2021-12-31

OKG considers this action in progress according to revised time plan.

5.2.2. Environmental Effect of the Coolant

Planned action
This topic will be handled in the LTO-project as part of the TLAAs.

Current progress
OKG's standpoint is still the same as in the original report – the work will be handled within the scope of the TLAAs and will be reported to SSM before December 31, 2021.
Deadline: 2021-12-31

OKG consider the action to be in progress

5.3. RAB (No actions)

5.4. Regulator's assessment and conclusions on ageing management of reactor pressure vessels

SSM agrees with the licensees that actions will be handled by the supervisory programme as well as the regulatory review of the PSR in order to ensure they are or will be completed.

6. Concrete Containment Structures and pre-stressed concrete pressure vessel

6.1. FKA

6.1.1. Plant walk-down

Planned action
Forsmark intends to further elaborate and expand these plant walk-downs to meet updated governing instruction.
Deadline: 2021-05-30

Current progress
In each ageing management review, an assessment of whether there is a need for a walk-down regarding scope or component status is being done.
If the need for a plant walk-down is deemed necessary, it will be planned and carried out accordingly.
In addition, regular inspections regarding containment structures have been improved with more defined acceptance criteria and documentation procedures to create a better basis for status management. These instructions and procedures have been implemented and thus verified by performing of inspection activities.

Forsmark considers the action resolved.

6.1.2. Cooperation

Planned action
A plant-specific list of degradation mechanisms will be harmonized against national and international experiences such as IGALL and GALL.

Deadline: 2020-12-31

Current progress
A new list with degradation mechanisms that are in line with IAEA NP-T-3.5 and IGALL has been developed for concrete structures. This list is already being used as a template in new and revised ageing management reviews for concrete structures to identify current degradation mechanisms and ageing effects. It has been used for several new ageing management reviews for concrete structures, for example concrete structures indoors and outdoors and will be used in a current revised review for the containment.
Since the USNRC is actively represented in the IAEA IGALL projects, any new or re-defined GALL NUREG-2192 ageing degradation mechanisms are continuously being implemented in the IGALL report updates.

Forsmark considers the action resolved.

6.1.3. Trending analysis

Planned action
Forsmark intends to further elaborate and expand instructions regarding trending and follow-up.
Deadline: ~~2020-12-31~~ New Plan 2022-06-01

Current progress
New instructions and routines for creating a long-term and robust way of working is being developed.
Some trend analyzes have already been performed. For example, for leakage testing of the containment, intermediate floor seals and tension cables.
Better defined acceptance criteria and requirements for documentation and reporting have been incorporated into existing instructions for maintenance. This has improved the reporting from maintenance inspections, which creates a better basis for trend analysis.
However, the complexity of trending analysis of status and performance within civil structures and components remains a more complex work to establish due to the nature of the structures and construction materials.
The trend analysis tools and KPIs for civil structures will be further developed and established through the newly implemented technical area group for civil structures and components. Due to this newly re-organized responsibility, the time frame for this action has been revised and set forward in time.

Forsmark considers this action in progress according to revised time plan.

6.1.4. Assessment of inaccessible and/or limited access structures

Planned action
Forsmark intends to inventory and review the occurrence of inaccessible structures.
Deadline: 2020-12-31

Current progress
An inventory of inaccessible areas and structures has been carried out by maintenance and engineering. Areas that are difficult to inspect have been identified. Thereafter, any consequences of this have been evaluated. In addition, alternative inspection methods and recommendations have been developed which are now being incorporated into ordinary inspection programmes in the form of clearer instructions and partly new inspection methods. One example of these inspection methods is the use of fiber optic cameras.

A guidance document for inspections has been developed, which prescribes certain methods to be used for inspection and evaluation of condition for some difficult to access civil structures and components of the pre-stressed reactor containments. This inspection methods will be tested and evaluated in the upcoming development of the inspection activities within ageing management of reactor containments, as well as civil structures in general. The development will be monitored and evaluated by the newly formed technical area group for civil structures.

Forsmark considers the action resolved.

6.2. OKG

Regarding the grouted tendons at unit 3, a monitoring test was performed 2020 to evaluate the behaviour. The test is a follow-up from the test performed in 2017.

The behaviour of the tendons and the concrete structure of the containment was monitored with strain gauges.
The test from 2020 is not yet fully evaluated but the preliminary results indicate a similar behaviour as in 2017, i.e. the behaviour of the structure was as expected. A comparison is also made with a theoretical FEM-analysis.
Since there is a big R&D test currently in progress in the permanently closed Barsebäck unit 2 reactor, the OKG test will be compared to the results from Barsebäck, once they are available.
The testing in Barsebäck is performed as a project within the scope of Energiforsk. The test is an attempt to evaluate the factual tension of grouted cables. Several material tests are performed, for the moisture profile of the concrete as well as of and for the tension cables. The purpose of the material tests is to calibrate the models that have been used, including re-evaluation of Oskarshamn unit 3 data.

6.2.1. Plant Walk-Down

Planned action
Plant walk- down

Current progress
As stated in a previous chapter, a new scope will be developed based on IAEA SSG 48. This new method for scoping will show if additional plant walk-downs will be necessary or not.
Deadline: 2023-12-31

OKG consider the action to be in progress

6.2.2. Development and Improvement

Planned action
Continuing the visual inspections, that shall be documented in the C3.5-report. In the C3.5 there is a great deal of information given, which can be used for trending.
The inspections will be ended approximately in the beginning of 2020, and with that almost every room at unit 3 will have been inspected. Naturally, there will be an amount of rooms left that must be handled in the future and which are stated in the C3.5-report. The information from the baseline will even be an input for updating the defect definitions for civil so the deadline is therefore set at 2021.

Current progress
The inspections are ongoing and the defect definitions related to Civil structure are today part of the AMPs.

The work with updating the defect-catalogue and updating of the definitions is now a part of the LTO project and will be done before the AMR work starts.
Deadline: 2021-12-31

OKG consider the action to be in progress.

6.2.3. Trending Analysis

Planned action
The rating scale for inspections needs to be further developed.

Current progress
During the visual inspections there is a table given in the report/protocol from the two previous inspections which shall be compared to the ongoing inspections.
The trending analysis needs to be further developed in order to help prevent the structure from degradation related to ageing. Trending is currently only performed regarding pre-stressing forces for un-grouted tendons. The work needs to be based on internal and international standards.
The rating scale for inspections needs to be further developed and will be finished in 2023 at the latest.
Deadline: 2023-12-31

OKG consider the action to be in progress

6.3. RAB

6.3.1. Trending analysis

Planned actions
Developed the rating scale for inspections further.
Deadline: 2020-12-31

Current progress
Ringhals has developed the rating scale that is used during inspections. The rating scale has five steps where 0 is no remarks and 4 is severe malfunction of the structure. Every step is also judged according to type of deviation/malfunction where A is degradation, B is risk of personal injury and C is risk of effecting safety functions. The rating scale is implemented and documented in the “Function description of aging management of civil structures”. However to be able to trend the results more inspections needs to be done.
In general, degradation of concrete structures are slow. The status of the structures are analyzed and actions are described in the strategic maintenance plans.
For the structures most important to safety (containment building and cooling water system) and for systems with many error reports (doors and hatches) system health reports are done. In these reports the structure gets a grade based on different criteria and this grade is trended.

During the last year Ringhals also has started to perform programme health analyses, see 2.3.1 . To ensure that the inspections are carried out in a reliable manner it is important to ensure that the quality of the programme is good. In the programme health report an ageing management programme gets a grade based on a multiple criteria analysis.
A few programme health reports have been done within the area of civil structures but it is too early to look at trends.

Ringhals consider this action resolved.

6.4. Regulator's assessment and conclusions on ageing management of concrete containment structures and pre-stressed concrete pressure vessel at the Swedish NPP

SSM agrees with the licensees that the actions that are considered to be resolved within the area concerning concrete containment structures and pre-stressed concrete pressure vessels have been resolved and the remaining actions will be handled by the supervisory programme ensure they will be completed.

6.5. Storage basins and connecting channels in concrete at Clab

6.5.1. Licensee´s assessment regarding generic findings from the TPR

The generic findings from the TPR assessment regarding concrete containment structures and pre-stressed concrete pressure vessels in nuclear power plants where:

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.

SKB position and action: N/A

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.

SKB position and action: The concrete structures are visually inspected and the leakage system is monitored. From the measures from the rock and basins movements the movements itself shows that the plain bearing is functional.

6.5.2. Regulators assessment of the ageing management of storage basins and connecting channels in concrete at Clab

According to the licensees the SCC are selected through the process of selecting systems and components. They state that SSC:s included in the SAR as a barrier or need to execute a safety function, direct or indirect, are within the scope of the overall AMP. The storage basins and connecting channels in concrete are included in the AMP since they have a main safety function, the radiation shielding function and a passive security function. SSM would like to point out the importance of including SSC:s (not belonging to a safety, radiation shielding and passive security function) but that might, if they malfunction, affect the function of SCC:s important to safety. SSM would like to further point out the

importance of plant walk-downs as a way to identify those systems. From an inspection, performed by the regulatory body in February 2017, it was concluded that SKB included those systems in the ageing management programme. SKB have documented those systems as well as systems that are not included in the ageing management programme and its motives for not being included.

SSM agrees with the licensee's approach to identify the environment conditions for the SSC in order to be able to identify the relevant degradation mechanism for each SCC.

SKB is part of collaboration with the Swedish Nuclear Power Plants licensees regarding for example identifying ageing mechanism based on IAEA documents (IGALL, Safety Report No 82 etc). SSM finds this to be a good example and our opinion is that the cooperation between the Swedish utilities is very important in order to understand and learn more about degradation mechanisms. However, in SSM's opinion SKB would benefit from being part of additional national and international research programmes, which would enable them to understand and learn more about ageing management of concrete structures.

During the TPR workshop, 2018 in Luxemburg, one of the challenges identified was "Acceptance criteria for the degradation mechanisms". The challenge defined, as "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." The definition of objective and comprehensive quantitative acceptance criteria for ageing management of concrete structures is a challenge for the industry as a whole and was recognized as such during the peer review in Luxemburg. SSM concludes from this review that this is also a challenge for SKB and Clab.

Based on this report, SSM concludes that SKB do not preform trending on a regular basis for concrete structure. It is SSM's opinion that trending on a regular basis would help the licensee to make informed decisions on when to take preventive or remedial action in order to prevent the structure from ageing related degradations.

SSM concludes that

- SKB has an Ageing Management Programme that includes SSC important to safety and SSC that might, if they malfunctioning affect the function of SCC important to safety.
- SKB is part of collaboration with the Swedish Nuclear Power Plants licensees regarding for example identifying ageing mechanism SSM finds this to be a good example. However, in SSM's opinion SKB would benefit from being part of more national and international research programmes, which enables them to understand and learn more about ageing management of concrete structures.
- During the TPR workshop, 2018 in Luxemburg, one of the challenges identified was "Acceptance criteria for the degradation mechanisms". SSM concludes from this review that this is also a challenge for SKB and Clab.
- SKB need to perform more trending analysis on a regular basis in order to prevent the structure from degradation related to aging.

7. Overall Assessment

Based on SSMs performance based requirement philosophy, Swedish licensees have pursued slightly different paths to develop their respective overall Ageing Management Programme, all with the goal to ensure the availability of required safety functions throughout the service life of the plant. Since SSM introduced a requirement for having an overall programme for ageing management in late 2004, all licenses has since after worked to systematically incorporate all the programmes to ensure a complete overall ageing management programme.

SSM considers that all licensee now have an overall Ageing Management Programme that fulfils SSM requirements and international expectations. The key elements used by the Swedish licensees to assess ageing are based on the nine attributes in NS-G-2.12, which are similar to the ten elements described in NUREG-1801 and the licensees are all currently working to be consistent with SSG-48 as well as other new international guides.

SSM found previously in the NAR that none of the Swedish licensees have been working with quality management of the overall Ageing Management Programme in a systematic manner. SSM concludes in this follow up that work is progressing in this area within the cooperation forum FORSAMP and find it to be important for the licensee to continue this cooperation as well as participating in international forums in order to improve quality management.

During the TPR workshop, 2018 in Luxemburg, one of the challenges identified was “Acceptance criteria for the degradation mechanisms”. SSM concludes from this review that this is also a challenge for Clab. Furthermore, SSM conclude that Clab need to perform more frequent trending analysis in order to prevent the structure from degradation related to aging.

SSM intends to continue to follow the progress of the licensee´s work with ageing management in the supervisory programme. This especially since it is apparent that some actions such as incorporating KPI and acceptance criteria have been postponed in the new plans.

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