



**IAEA**

International Atomic Energy Agency

REPORT OF THE

**SAFETY REVIEW MISSION  
ON AGEING MANAGEMENT  
AND CONTINUED SAFE OPERATION**

TO THE

**HIGH FLUX REACTOR**

**PETTEN, NETHERLANDS, KINGDOM OF THE**

**21 – 28 June 2022 (Main Mission)**

and

**3 – 5 July 2024 (Follow-up Mission)**

DEPARTMENT OF NUCLEAR SAFETY AND SECURITY  
DIVISION OF NUCLEAR INSTALLATION SAFETY

## **PREAMBLE**

This report presents the results of the IAEA safety review mission on ageing management and continued safe operation of the High Flux Reactor (HFR), the Kingdom of the Netherlands. It includes recommendations and suggestions for improvement of ageing management and continued safe operation for consideration by the responsible Dutch authorities.

Any use of or reference to this report that may be made by the competent Dutch organizations is solely their responsibility.

# INTERNATIONAL ATOMIC ENERGY AGENCY

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**Main Mission Date:** 21 – 28 June 2022

**Location:** Petten, Netherlands, Kingdom of the

**Facility:** High Flux Reactor (HFR)

**Organized by:** IAEA at the request of the Authority for Nuclear Safety and Radiation Protection (ANVS), Netherlands, Kingdom of the

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**Follow-up Mission Date:** 3 – 5 July 2024

**Location:** Petten, Netherlands, Kingdom of the

**Facility:** High Flux Reactor (HFR)

**Organized by:** IAEA at the request of the Authority for Nuclear Safety and Radiation Protection (ANVS), Netherlands, Kingdom of the

<b>Conducted by:</b>	Mr K. Sun	RRSS/NSNI –Team Leader
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## EXECUTIVE SUMMARY

### MAIN MISSION

This mission was conducted at the request from Authority for Nuclear Safety and Radiation Protection (ANVS), the regulatory body of the Kingdom of the Netherlands. The mission was conducted during the period 21 – 28 June 2022 at the High Flux Reactor (HFR), Petten, the Kingdom of the Netherlands. HFR is located about 50 kilometres north of Amsterdam and is owned by the Joint Research Centre (JRC) and operated by the Nuclear Research and consultancy Group (NRG). HFR is in operation since 1961 and is currently expected to continue its service until it is replaced by a new reactor.

The IAEA team consisted of three IAEA staff members and four international experts. The mission was conducted in accordance with the methodology of the IAEA Safety Aspects of Long-Term Operation (SALTO) mission. The mission covered organization of ageing management and continued safe operation (CSO) activities; screening of the structures, systems and components (SSCs) and reactor programmes; and ageing management for mechanical, electrical, instrumentation and control (I&C), and civil SSCs.

The IAEA team concluded that in addition to the intensive work that has been performed during the past several years to deal with ageing effects, HFR has made a significant progress in the establishment of a systematic ageing management programme and preparation for CSO. The IAEA safety standards were used as a main reference for the development and implementation of this programme and activities.

The IAEA team also assessed that the IAEA safety standards have been considered in the development and implementation of the facility's operating programmes that have interface with ageing management and CSO, including maintenance, surveillance, inspection, periodic safety review and equipment qualification. The team encouraged the continuation of this practice in all activities related to these programmes, as there is still a large amount of work to be completed and there may be a number of challenges to be overcome to ensure the effective implementation of ageing management.

The IAEA team evaluated that basis for ageing management, including regulatory requirements, exists and that HFR has made significant efforts over the years to reconstitute the design basis of the SSCs.

The IAEA team appreciated the high quality of the discussions during the mission and noted the professionalism of the HFR management and staff as well as their commitment and involvement in the relevant activities. The team noted good performances with respect to:

- Establishment of a clear policy for ageing management and CSO, and the demonstrated strong commitment of the NRG senior management to safety and to the effective implementation of the relevant activities;
- Assignment of a dedicated ageing management coordinator at the facility level;
- Planning and implementation of modification projects and refurbishment in accordance with the IAEA safety standards;
- Systematic planning and implementation of a multi-disciplinary surveillance programme on the embrittlement of the reactor vessel, considering modelling, measurements, and use of scientific research to ensure compliance with the design requirements;

- Implementation of periodic safety reviews since 2002 and use of their findings in ageing management.

The IAEA team identified gaps against the IAEA safety standards and provided recommendations and suggestions to address these gaps. These recommendations and suggestions were related to the need for:

- Ensuring systematic implementation of the obsolescence programme, including establishing procedures covering all relevant management actions and providing training on implementation of the programme;
- Improving the methodology and implementation of SSCs screening for ageing management and CSO through:
  - Covering the SSCs that are not important to safety, but their failure can prevent those important to safety from performing their safety functions;
  - Ensuring that all SSCs classified as Safety Class 1, 2, and 3 are covered by the scope;
  - Establishing procedures to ensure the completeness of the master list of SSCs and performance of dedicated walkdowns.
- Completing the establishment of appropriate acceptance criteria for all ageing management programmes (AMPs);
- Further enhancing ageing management through establishing procedures for addressing the interaction (interface) of ageing management activities with the plant operating programmes; and for ensuring systematic trending analysis.
- Updating the ageing management review (AMR) methodology and to perform them for all in-scope civil structures and components ensuring identification of design basis, current condition, and degradation mechanisms and their effects;
- Reviewing and revising, as necessary, the AMPs to ensure they are in accordance with ageing management elements established by the IAEA safety standards, including ensuring their specificity to the SSCs under consideration, identification of condition indicators, degradation mechanisms, monitoring, and ageing management actions;
- Initiating a process for identification of cables, and accordingly, installing proper labelling, and considering the implementation of physical separation between redundant safety channels in future modernization of electrical and I&C systems;
- Performing periodical chemical analysis of leaking water from the pools and utilizing the results to improve the ageing management of pools' structure;
- Establishing a maintenance programme for the spare parts of SSCs important to safety and controlling and monitoring of the storage conditions.

These recommendations and suggestions were agreed by NRG and HFR management, who expressed their commitment to implement them, and to request an IAEA follow up review. The representatives of ANVS also expressed their commitment to follow-up on the implementation of the recommendations and suggestions of this mission.

## FOLLOW-UP MISSION

This mission was conducted at the request from Authority for Nuclear Safety and Radiation Protection (ANVS), the regulatory body of the Kingdom of the Netherlands. The mission was conducted during the period 3 – 5 July 2024 at the High Flux Reactor (HFR), Petten, the Kingdom of the Netherlands.

The IAEA team consisted of an IAEA staff member: Mr K. Sun (IAEA Team Leader, RRSS), and two international experts: Mr J. Chakovski (Australia) and Ms J. Tcherner (Canada). The main counterpart of this mission was Mr R. Nel, HFR Reactor Manager.

The IAEA team reviewed the progress in solving each of the issues identified by the 2022 main mission. The team noted that HFR had progressed in solving most of the issues. The resolution degree was determined by the team for each issue sheet separately, with the following results:

- Four out of nine issues (i.e. Issues A-1, B-1, B-2, and C-2) were assessed as “issue resolved”:
  - Issue A-1: The obsolescence management programme, including the associated staff training, have been systematically implemented. The dedicated screening process for obsolescence management and comprehensiveness of the implementation log can be highlighted;
  - Issue B-1: The screening methodology has been further aligned with the IAEA safety standards by inclusion of items that are not important to safety but their failure may prevent SSCs important to safety from performing their intended safety functions;
  - Issue B-2: The effectiveness of the ageing management activities has been further enhanced. The trend monitoring of the chemical analysis results for the reactor pool leaking water and measurement results for the differential settlement between buildings can be highlighted;
  - Issue C-2: A maintenance programme of spare parts for SSCs important to safety have been established. The development of a user-friendly database for spare parts, including the information of their shelf life, can be highlighted.
- Four out of nine issues (i.e. Issues C-1, D-1, E-1, and E-2) were assessed as “satisfactory progress to date”:
  - Actions have been taken to resolve Issue C-1 on the review and revision of AMPs for mechanical SSCs in accordance with ageing management elements, Issue D-1 on completion of in-scope electrical and I&C AMPs, and Issue E-2 on the review and revision of AMPs for civil SSCs in accordance with ageing management elements. The efforts that were exerted as well as the established plans indicate that the mission’s recommendations associated with these issues will be resolved within a reasonable timeframe after the follow-up mission. The IAEA team also noted that all these issues are relevant to the individual AMPs, which have a continued nature and need for long-term actions;
  - Issue E-1: The AMR methodology has been updated by HFR in accordance with the IAEA Safety Standards Series No. SSG-48, Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants. Condition assessments for the in-scope structures have been performed. However, a systematic identification of the degradation mechanisms considering the inputs from the condition assessments has not yet been completed;
  - A new suggestion is thus provided for further guidance to ensure resolution of Issue E-1: HFR should consider performing specific AMRs for the in-scope structures and components that may be organized in commodity groups based on similarities in their functions, materials, and environment. It is also suggested to prioritize structures and

components subjected to the degradation mechanisms that can potentially result in the degradations having a greater safety consequence, e.g., foundations and pools;

- Both suggestions from the main CSO mission, on physical separation between redundant safety channels (Issue D-1) and on performing periodical chemical analysis of leaking water from the pools (Issue E-1), respectively, have been fully addressed by HFR.
- One issue (A-2) was assessed with “insufficient progress to date” and require additional efforts:
  - Issue A-2: Considerable efforts have been made by HFR to investigate and monitor the current conditions of the in-scope SSCs. Acceptance criteria in the AMPs are, however, still not appropriately established.

A new recommendation is thus provided by the follow-up mission for further guidance for resolving Issue A-2: Appropriate acceptance criteria for the inspection and monitoring of ageing effects on in-scope SSCs should be further developed based on the design basis for items important to safety or on the technical requirements for the structure or component, as well as on the relevant regulatory requirements, codes and standards, so that a corrective action can be implemented before loss of the intended function of the structure or component.

The above conclusions were agreed by NRG and HFR management during the exit meeting. The counterparts expressed a determination to continue to address the remaining issues and continue cooperation with the IAEA. The representatives of ANVS also expressed their commitment to follow-up on the HFR implementation.

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# 1. INTRODUCTION

## 1.1. OBJECTIVE

The objective of the mission was to review the status and future plans for the ageing management programme and continued safe operation (CSO) activities performed at the High Flux Reactor (HFR), Petten, the Kingdom of the Netherlands, against the IAEA safety standards and to provide recommendations and suggestions for further improvements.

## 1.2. SCOPE

The mission was conducted in accordance with the IAEA Safety Aspects of Long-Term Operation (SALTO) Peer Review Guidelines, SVS 26 (Rev. 1) [1], which is adapted for research reactors. The scope of the mission covered:

- A. Organization of ageing management and CSO activities;
- B. Screening of SSCs and reactor programmes;
- C. Ageing management of mechanical SSCs;
- D. Ageing management of electrical and I&C SSCs;
- E. Ageing management of civil SSCs.

## 1.3. CONDUCT OF THE MISSION

### 1.3.1. Conduct of the main mission

The following documents and information were used as the basis for the review:

- IAEA SALTO Peer Review Guidelines [1];
- IAEA Safety Standards [2-16];
- IAEA Technical Publication [17];
- Preparatory Meeting Report [18];
- Advance Information Package [19-27].

The IAEA team consisted of three IAEA staff members: Mr A. Shokr (IAEA Team Leader, Research Reactor Safety Section (RRSS)), Mr K. Sun (Deputy Team Leader, IAEA RRSS), and Mr G. Petofi (IAEA OSS), and four international experts: Mr N. De Lorenzo (Argentina), Mr C. Morris (Australia), Ms J. Tchner (Canada), and Mr D. Rao (India). The main counterpart of this mission was Mr O. Wouters, HFR Reactor Manager. Mr B. Leeftink, NRG CEO, Mr J. Offerein, NRG Operations Manager, and representatives of ANVS and JRC participated during the opening meeting of the mission. Representatives from ANVS participated, as observers, in several sessions during the mission. Mr L.M. van der Heijdt, ANVS Department Head for Nuclear Installations and Transport, participated during the exit meeting. The list of mission participants is given in Section 7.

The activities of the mission included review of the advanced information package, walkdown of the reactor facility, discussions between the IAEA team and the NRG and HFR management and technical staff, discussion between team members, and development of Issue Sheets and mission conclusions and recommendations. The discussions in the mission, except the opening and exit meetings, were implemented in parallel sessions, with additional discussion sessions as needed. The agenda of the mission is provided in Appendix II.

The counterparts and HFR management were daily informed of the IAEA team's observations. Agreements on facts and on gaps against the IAEA safety standards were made between the team and relevant counterparts. On the day before the exit meeting, the team finalized the identification

of the issues, developed the Issue Sheets, and discussed the comments of the counterparts on the recommendations and suggestions of the mission.

This mission report describes the conclusions and the findings of the mission. The text reflects only those areas in which the IAEA team considered that a recommendation, a suggestion, an encouragement, or a good performance is appropriate. No text is included for areas of the review scope where no safety issue was identified based on the review.

The exit meeting was held on 28 June 2022. At this meeting, the mission conclusions and findings, including recommendations, suggestions, encouragements, and good performances, were presented. The conclusions and findings were agreed by the NRG and HFR management.

### **1.3.2. Conduct of the follow-up mission**

The follow-up mission was organized to review the appropriateness and progress of solutions to the main CSO mission issues. HFR provided to the IAEA Advanced Information Packages, including technical documents [28 – 37] describing actions to implement the recommendations and suggestions of the main CSO mission.

The IAEA team consisted of an IAEA staff member: Mr K. Sun (IAEA Team Leader, RRSS), and two international experts: Mr J. Chakovski (Australia) and Ms J. Tcherner (Canada). The main counterpart of this mission was Mr R. Nel, HFR Reactor Manager. Mr J. Offerein, NRG Operations Manager and Mr B. Keller, ANVS Director Competent Authority, participated during the entry meeting of the mission. The list of mission participants is provided in Section 7.

The three-day follow-up mission included an introductory presentation of HFR, discussions, and interviews of responsible counterparts. These were the basis for the assessment of the status of issues as presented in this report. The agenda of the mission is provided in Appendix II.

The exit meeting was held on 5 July 2024. At this meeting, the mission results and conclusions on the assessment of implementation of the recommendations and suggestions of the mission were presented to and agreed by the NRG and HFR management. Ms A. van Bolhuis, ANVS Chair of the Board, and Mr B. Leeftink, CEO of the Executive Board of PALLAS and NRG, participated in the exit meeting.

## **1.4. SUMMARY INFORMATION OF THE REACTOR**

### **1.4.1. General information**

HFR, operated since 1961 and located 50 kilometres north of Amsterdam in Petten, is a light water cooled and moderated, tank-in-pool, multi-purpose research reactor. It uses low enriched uranium plate-type fuel elements with beryllium as a reflector. The maximum power is 50 MW and the reactor nominally operates at 45 MW. The HFR is owned by the JRC and operated by NRG. The reactor has eight to nine operating cycles per year with a four-day maintenance outage in between and two longer outages for larger activities and modifications each year. HFR has 20 in-core and 12 pool-side irradiation positions, and 12 beam tubes. The in-core positions are mainly employed for material irradiation, experiments and fuel irradiation programmes. Radioisotope production is performed at both in-core and pool-side irradiation positions and the reactor currently supplies medical isotopes for 30,000 procedures per day. HFR is currently expected to continue its service until it is replaced by the planned new research reactor, PALLAS, which is planned to be constructed on the same Petten site.

### **1.4.2. Regulatory framework for ageing management and CSO**

ANVS enforces and verifies the application of the rules for nuclear safety of nuclear installations. These rules are published by the national Ministry of Infrastructure and Environment jointly with the Ministry of Social Affairs and Employment (Minister van Infrastructuur en Milieu en de Minister van Sociale Zaken en Werkgelegenheid) on the Government Gazette (Staatscourant). These rules apply to all nuclear installations in the Kingdom of the Netherlands, including HFR. In Article 11 (Continuous improvement and safety evaluations), point 4.b states that the ageing of the installation shall be taken into account during Periodic Safety Reviews (PSRs).

### **1.4.3. HFR CSO policy**

The HFR license specifies that the operating organization shall set up an ageing management process wherein all ageing mechanisms that impact safety relevant SSCs are identified, their consequences determined and wherein the necessary activities for ageing management are determined. This programme shall be evaluated every ten years as part of the PSR. HFR has implemented PSRs since 2002 and uses the findings for ageing management activities.

Since the Dutch regulatory framework contains no specific requirements and guides regarding research reactor ageing management, the international guidelines, in particular the IAEA safety standards, are followed for the development of the ageing management programme for HFR. More specifically, IAEA Safety Requirements SSR-3 [2] and Safety Guide SSG-10 [3] are used as the primary basis for the HFR CSO policy. In addition, Safety Guide SSG-48 [4] is used as a supplementary reference.

## 2. MAIN CONCLUSIONS

### 2.1. CONCLUSIONS OF THE MAIN MISSION

Based on the activities of the mission, the IAEA team concluded that in addition to the intensive work that has been performed during the past several years to deal with ageing effects, HFR has made significant progress in the establishment of a systematic ageing management programme and preparation for continued safe operation (CSO). The IAEA safety standards were used as a main reference for the development and implementation of this programme and activities.

The IAEA team also assessed that the IAEA safety standards have been considered in the development and implementation of the facility's operating programmes that have interface with ageing management and CSO, including maintenance, surveillance, inspection, periodic safety review (PSR) and equipment qualification (EQ). The team **encouraged** the continuation of this practice in all activities related to these programmes, as there is still a large amount of work to be completed and there may be a number of challenges to be overcome to ensure the effective implementation of ageing management.

The IAEA team evaluated that the basis for ageing management, including regulatory requirements, exists and that HFR has made significant efforts over the years to reconstitute the design basis of the SSCs. In this regard, the IAEA team **encouraged** HFR to finalize the development of the document on "*Criteria for design of structures, systems, and components for HFR*", which covers engineering codes and standards that are used as basis for ageing management.

The IAEA team appreciated the high quality of the discussions during the mission and noted the professionalism of the HFR management and staff as well as their commitment and involvement in the relevant activities. The team noted **good performances** with respect to:

- Establishment of a clear policy for ageing management and CSO, and the demonstrated strong commitment of the NRG senior management to safety and to the effective implementation of the relevant activities;
- Assignment of a dedicated ageing management coordinator at the facility level;
- Planning and implementation of modification projects and refurbishment in accordance with the IAEA safety standards;
- Systematic planning and implementation of a multi-disciplinary surveillance programme on the embrittlement of the reactor vessel, considering modelling, measurements, and use of scientific research to ensure compliance with the design requirements;
- Implementation of periodic safety reviews since 2002 and use of their findings in ageing management.

The IAEA team observed that a number of reportable events occurred during the period between 2008 and 2022. Ageing has been identified as the main root cause of these events. Most of these events at the HFR have not resulted in a radioactive release, although they are of safety significance. Some of these events were repetitive (e.g. the deformation of beryllium reflectors in 2020) and could have been prevented if feedback from the facility operating experience were used more effectively. The team noted an improved facility performance, where lessons from the 2020 beryllium deformation were used to establish ageing management activities to prevent the recurrence of such events in the future. The team **encouraged** HFR to continue this practice.

The IAEA team also identified issues and gaps against the IAEA safety standards and provided **recommendations** and **suggestions** to address these issues. These recommendations and suggestions were related to the need for:

- Ensuring systematic implementation of the obsolescence programme, including establishing procedures covering all relevant management actions and providing training on implementation of the programme;
- Improving the methodology and implementation of SSCs screening for ageing management and CSO through:
  - Covering the SSCs that are not important to safety, but their failure can prevent those important to safety from performing their safety functions;
  - Ensuring that all SSCs classified as Safety Class 1, 2, and 3 are covered by the scope;
  - Establishing procedures to ensure the completeness of the master list of SSCs (SCsML) and conducting dedicated walkdowns.
- Completing the establishment of appropriate acceptance criteria for all ageing management programmes (AMPs), thus supporting the timely identification and implementation of necessary ageing management actions;
- Further enhancing ageing management through establishing procedures for:
  - Addressing the interaction (interface) of ageing management activities with the plant operating programmes; and
  - Ensuring systematic trending analysis.
- Updating the ageing management review (AMR) methodology in accordance with the IAEA safety standards and performing AMRs for all in-scope civil structures and components ensuring identification of design basis, current condition, and degradation mechanisms and their effects;
- Reviewing and revising, as necessary, the AMPs to ensure they are in accordance with ageing management attributes (elements) established by the IAEA safety standards, including ensuring their specificity to the SSCs under consideration, identification of condition indicators, degradation mechanisms, monitoring, and ageing management actions;
- Initiating a process for identification of cables, and accordingly, installing proper labelling, and considering the implementation of physical separation between redundant safety channels in future modernization of electrical and I&C systems;
- Performing periodical chemical analysis of leaking water from the pools and utilizing the results to improve the ageing management of pools' structure;
- Establishing a maintenance programme for the spare parts of SSCs important to safety and controlling and monitoring of the storage conditions.

The evaluation of each review area, including discussions of the recommendations and suggestions, is included in the following subsections.

## 2.2. CONCLUSIONS OF THE FOLLOW-UP MISSION

The IAEA follow-up team reviewed the progress in solving each of the issues identified by the 2022 main mission. The team noted that HFR had progressed in solving most of the issues. The resolution degree was determined by the team for each issue sheet separately, with the following results:

- Four out of nine issues (i.e. Issues A-1, B-1, B-2, and C-2) were assessed as “issue resolved”:
  - Issue A-1: The obsolescence management programme, including the associated staff training, have been systematically implemented. The dedicated screening process for

obsolescence management and comprehensiveness of the implementation log can be highlighted;

- Issue B-1: The screening methodology has been further aligned with the IAEA safety standards by inclusion of items that are not important to safety but their failure may prevent SSCs important to safety from performing their intended safety functions;
  - Issue B-2: The effectiveness of the ageing management activities has been further enhanced. The trend monitoring of the chemical analysis results for the reactor pool leaking water and measurement results for the differential settlement between buildings can be highlighted;
  - Issue C-2: A maintenance programme of spare parts for SSCs important to safety have been established. The development of a user-friendly database for spare parts, including the information of their shelf life, can be highlighted.
- Four out of nine issues (i.e. Issues C-1, D-1, E-1, and E-2) were assessed as “satisfactory progress to date”:
    - Actions have been taken to resolve Issue C-1 on the review and revision of AMPs for mechanical SSCs in accordance with ageing management elements, Issue D-1 on completion of in-scope electrical and I&C AMPs, and Issue E-2 on the review and revision of AMPs for civil SSCs in accordance with ageing management elements. The efforts that were exerted as well as the established plans indicate that the mission’s recommendations associated with these issues will be resolved within a reasonable timeframe after the follow-up mission. The IAEA team also noted that all these issues are relevant to the individual AMPs, which have a continued nature and need for long-term actions;
    - Issue E-1: The AMR methodology has been updated by HFR in accordance with the IAEA Safety Standards Series No. SSG-48, Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants. Condition assessments for the in-scope structures have been performed. However, a systematic identification of the degradation mechanisms considering the inputs from the condition assessments has not yet been completed;
    - A new suggestion is thus provided for further guidance to ensure resolution of Issue E-1: HFR should consider performing specific AMRs for the in-scope structures and components that may be organized in commodity groups based on similarities in their functions, materials, and environment. It is also suggested to prioritize structures and components subjected to the degradation mechanisms that can potentially result in the degradations having a greater safety consequence, e.g., foundations and pools;
    - Both suggestions from the main CSO mission, on physical separation between redundant safety channels (Issue D-1) and on performing periodical chemical analysis of leaking water from the pools (Issue E-1), respectively, have been fully addressed by HFR.
  - One issue (A-2) was assessed with “insufficient progress to date” and require additional efforts:
    - Issue A-2: Considerable efforts have been made by HFR to investigate and monitor the current conditions of the in-scope SSCs. Acceptance criteria in the AMPs are, however, still not appropriately established.
    - A new recommendation is thus provided by the follow-up mission for further guidance for resolving Issue A-2: Appropriate acceptance criteria for the inspection and

monitoring of ageing effects on in-scope SSCs should be further developed based on the design basis for items important to safety or on the technical requirements for the structure or component, as well as on the relevant regulatory requirements, codes and standards, so that a corrective action can be implemented before loss of the intended function of the structure or component.

A summary of the results was presented to the NRG and HFR management during the exit meeting held on 5 July 2024. The counterparts expressed a determination to continue to address the remaining issues and continue cooperation with the IAEA. The representatives of ANVS also expressed their commitment to follow-up on the HFR implementation.

### 3. DETAILED CONCLUSIONS FOR REVIEW AREAS

#### 3.1. ORGANIZATION OF AGEING MANAGEMENT AND CSO ACTIVITIES

##### **Related regulatory requirements, codes and standards for ageing management and regulatory review**

The basis for ageing management and CSO is defined for HFR. The IAEA safety standards are used as the main reference for developing the plant level ageing management programme (PLAMP) and AMPs as well as the related operating documents.

Codes and standards are included in the safety analysis report (SAR) but not for all the SSCs. These codes and standards were defined for all refurbishment and modernization projects and are being documented. The IAEA team **encouraged** HFR to finalize the development of the document on “*Criteria for design of structures, systems, and components for HFR*” which covers engineering codes and standards that are used as basis for ageing management.

##### **Principles and approach to ageing management and CSO**

A clear policy, in line with the IAEA safety standards, on ageing management and CSO is established and being implemented. The IAEA team recognized the strong commitment of the NRG senior management to safety and to the effective implementation of the relevant activities as a **good performance**.

##### **Organizational arrangements for ageing management and CSO**

The organizational structure approach for ageing management and CSO followed by the facility is in line with the IAEA safety standards. An ageing management coordinator was recruited and assigned relevant responsibilities in 2021. The IAEA team recognized the assignment of a dedicated ageing management coordinator at the facility level as a **good performance**.

##### **Periodic safety review**

The IAEA team evaluated that the implementation of PSRs since 2002 and use of their findings in ageing management as a **good performance**.

##### **Ageing management programme**

HFR has not yet considered all obsolescence management actions that are established by the IAEA safety standards (i.e. identification of useful service life with foresight and anticipation, preparation of modification projects, provision of spare parts, or identification of alternative suppliers). Additionally, there is no formal training of the staff on the implementation of the obsolescence management programme. The IAEA team **recommended** that systematic implementation of the obsolescence management programme should be ensured, including among others by establishing procedures considering all relevant management actions that are recommended by the IAEA Safety Standards No. SSG-10. A formal training programme should be established for the involved HFR staff across the mechanical, electrical, I&C, and civil areas, to ensure the effectiveness in the implementation of the programme (see *Issue Sheet A-1*).

Some of the AMPs (or the procedures referenced thereof) are lacking acceptance criteria, and some others include inappropriate acceptance criteria. The IAEA team recommended that appropriate acceptance criteria should be established for all AMPs, thus supporting the timely identification and implementation of necessary ageing management actions. Such criteria should be established based on design basis, technical requirements, applicable codes and standards, and considering availability of sufficient safety margins (see *Issue Sheet A-2*).

## **Configuration management, utilization and modification**

Modifications on the HFR are planned and implemented as per a dedicated procedure for managing of changes (MoC) which is in accordance with the IAEA safety standards. The configuration of the facility is managed in different databases (asset management, documentation management, and SCsML). The planning and implementation of modification projects and refurbishment in accordance with the IAEA safety standards was recognized as a **good performance** by the IAEA team.

## **Safety analysis report**

The SAR, complementing the safety report that is required by the national regulator, is under development. HFR staff mentioned that the PLAMP will be updated based on the approved SAR. No recommendations, suggestions, encouragements, good practices or good performances were identified in this area.

## **Status at follow-up mission**

In this review area, there were two issues presented by the IAEA team in 2022:

- Issue A-1: Incomplete obsolescence management programme;
- Issue A-2: Deficiencies in acceptance criteria for ageing management programmes.

In **Issue A-1**, a recommendation was provided that “Systematic implementation of the obsolescence management programme should be ensured, including among others by establishing procedures considering all relevant management actions that are recommended by the IAEA Safety Standards No SSG-10. A formal training programme should be established for the involved HFR staff across the mechanical, electrical, I&C, and civil areas, to ensure the effectiveness in the implementation of the programme”.

HFR revised in September 2023 the Technological Obsolescence Programme, which was developed in August 2022. An approach of the scope and screening process for the obsolescence management is described in the programme. The obsolescence screening has been implemented systematically to all in-scope SSCs. A formal training module for relevant HFR staff, including maintenance technicians, system engineers and reactor operators, has been developed for ageing management, including obsolescence management.

## **Conclusion: Issue A-1 resolved.**

In **Issue A-2**, a recommendation was provided that “Appropriate acceptance criteria should be established for all AMPs, thus supporting the timely identification and implementation of necessary ageing management actions. Such criteria should be established based on design basis, technical requirements, applicable codes and standards, and considering availability of sufficient safety margins”.

HFR developed a methodology in August 2023 to establish acceptance criteria for periodic preventative maintenance (PPOs) of electrical and I&C SSCs. The methodology is primarily applicable to instruments subjected to regular field calibrations. Acceptance criteria for the several civil SSCs have also been investigated, but only the results of conditional assessment were referenced in the acceptance criteria, not the design basis of in-scope SSCs. In general, the specifications of the newly developed acceptance criteria in the AMPs were found to be unclear and need further improvements.

## **Conclusion: Insufficient progress to date for Issue A-2.**

A new recommendation is provided for further guidance for resolving Issue A-2:

**R)** Appropriate acceptance criteria for the inspection and monitoring of ageing effects on in-scope SSCs should be further developed based on the design basis for items important to safety or on the technical requirements for the structure or component, as well as on the relevant regulatory requirements, codes and standards, so that a corrective action can be implemented before loss of the intended function of the structure or component.

### 3.2. SCREENING OF SSCS AND REACTOR PROGRAMMES

#### **Methodology and criteria for screening of SSCs for ageing management and CSO**

The IAEA team determined that the screening methodology does not cover SSCs that are not important to safety, but their failure may prevent those SSCs important to safety from performing their intended safety functions. The scope of SSCs for ageing management and CSO does not cover all SSCs important to safety. The IAEA team **recommended** that the screening methodology should be further aligned with the IAEA safety standards by including items that are not important to safety but whose failure may prevent SSCs important to safety from performing their intended safety functions. The scope for ageing management and CSO should be expanded to cover all the SSCs classified as Safety Class 1, 2, and 3 (see *Issue Sheet B-1*).

The IAEA team also **recommended** to further enhance application of the screening methodology through development of procedures for dedicated walkdowns and ensuring the completeness of the Master list (see *Issue Sheet B-2*).

#### **Maintenance, in-service inspection, and surveillance programmes**

There is a maintenance programme at HFR including preventive and corrective maintenance activities and aligned with IAEA safety standards. The feedback from the corrective maintenance is used for adjusting AMP activities. For mechanical SSCs, the IAEA team provided a recommendation on the maintenance of the spare parts (see *Issue Sheet C-2*). In addition, for electrical and I&C components, there is no maintenance programme, or database, for spare parts (see Section 3.4).

There is an in-service inspection programme established based on the IAEA safety standards and it covers the reactor vessel and the primary cooling system. This programme defines relevant baseline data and provides for adjustment of the inspection frequency.

There is a surveillance programme on neutron embrittlement of the reactor vessel established at HFR. Other surveillance activities are covered by the maintenance programme.

There is a water chemistry programme, as recommended by the IAEA safety standards, in place at HFR. The IAEA team provided a suggestion on further enhancement of this programme (see *Issue Sheet E-1*).

The IAEA team **recommended** the enhancement of the effectiveness of ageing management activities by establishing procedures for (see *Issue Sheet B-2*):

- Adequately addressing the interaction (interface) and ensuring consistency of activities on ageing management and CSO with the other operating programmes and documentation such as maintenance, inspection, surveillance, modification, safety analysis, and SAR;
- Systematic collection, analyses, and trending of the reactor operating data, including those from functional and periodic testing, maintenance, inspection, and surveillance, and utilizing the results for continuous improvement of the ageing management programmes.

## Equipment qualification programme

An equipment qualification programme, developed based on the IAEA safety standards, is in place. The programme takes into account the harsh conditions identified in the deterministic safety report. The IAEA team **encouraged** the HFR to continue this practice in the development and implementation of the facility's operating programmes that have interface with ageing management and CSO, including equipment qualification.

### Status at follow-up mission

In this review area, there were two issues identified by the main mission in 2022:

- Issue B-1: Deficiencies in screening of SSCs for ageing management and CSO;
- Issue B-2: Need to further improve the effective implementation of the PLAMP.

In **Issue B-1**, a recommendation was provided that “The screening methodology should be further aligned with the IAEA safety standards by including items that are not important to safety but their failure may prevent SSCs important to safety from performing their intended safety functions. The scope for ageing management and CSO should be expanded to cover all the SSCs classified as Safety Class 1, 2, and 3”.

The in-scope SSCs for HFR ageing management were screened in accordance with their safety classes. After the main mission, the methodology for SSCs screening has been revised in the PLAMP to include a feedback loop for SSCs considered not important to safety, but their failure can result in a decrease in reliability. HFR staff indicated that the screening process generally followed the safety based approach outlined in IAEA Safety Standards Series No. SSG-10 (Rev. 1), Ageing Management for Research Reactors, but they adjusted the implementation process for each level of screening based on the actual HFR situations.

### Conclusion: Issue B-1 resolved.

In **Issue B-2**, a recommendation was provided as the following: “To further enhance the effectiveness of ageing management activities, procedures should be established for:

- Adequately addressing the interaction (interface) and ensuring consistency of activities on ageing management and CSO with the other plant operating programmes and documentation such as maintenance, inspection, surveillance, modification, safety analysis, and safety analysis report.
- Ensuring the completeness and regular update of the SCsML for ageing management and CSO. Sources of information that could be used for such update include use of the process and instrumentation diagrams, facility's documentation, and results of dedicated walkdowns for SSC screening.
- Planning and implementation of dedicated walkdowns for ageing management purposes.
- Systematic collection, analyses, and trending of the reactor operating data, including those from functional and periodic testing, maintenance, inspection, and surveillance, and utilizing the results for continuous improvement of the ageing management programmes.”

HFR updated the PLAMP to provide more comprehensive guidance on interface management. Descriptions have been added for each of the interactions between relevant parts of ageing management and other programmes/processes. A comprehensive walkdown procedure has been developed. It aims to support proactive ageing management, condition assessment, and continuous improvement of ageing management by adjusting the scope. Trending analysis has also been performed since the main mission to systematically analyse the reactor operating data, including chemical analysis of leaking water from the pools, measurements of differential settlement between HFR buildings.

### Conclusion: Issue B-2 resolved.

### 3.3. AGEING MANAGEMENT OF MECHANICAL SSCS

#### **Ageing management review of mechanical SSCs**

The AMR of mechanical SSCs important to safety has generally been performed based on the IAEA safety standards. No recommendations, suggestions, encouragements, good practices or good performances were identified in this area.

#### **Ageing management programme of mechanical SSCs**

HFR has developed a PLAMP and tens of AMPs for the SSCs. These programmes are incorporating references to other facility programmes such as maintenance and inspections that support ageing management. Most AMPs were developed in 2020, and the majority of them were recently revised.

Many AMPs have not yet been implemented. Not all attributes (elements) that are recommended by the IAEA safety standards are addressed by several AMPs. The IAEA team observed deficiencies in sample AMPs, which were reviewed during the mission. The IAEA team **recommended** that AMPs for mechanical SSCs should be reviewed and revised, as needed, to ensure that they are in accordance with the ageing management attributes (elements) established by the IAEA safety standards, including ensuring their specificity to the SSCs under consideration covering all applicable degradation mechanisms, monitoring, acceptance criteria, and ageing management actions (see *Issue Sheet C-1*).

There is no programme for maintenance of spare parts for SSCs important to safety. The storage conditions are not controlled or monitored. The spare parts management system does not take into account the shelf life and storage conditions. There is no database for spare electrical and I&C components and the stock is maintained by technicians within well marked drawers. The IAEA team **recommended** that a maintenance programme of spare parts for SSCs important to safety should be established, including control and monitoring of the storage conditions (see *Issue Sheet C-2*).

#### **TLAAs of mechanical SSCs**

Time limited ageing analyses (TLAAs) were performed following the International Generic Ageing Lessons Learned (IGALL) for Nuclear Power Plants reports with examples of the TLAAs, taking into account the applicable and relevant ones. Eight TLAAs were identified and six of which for mechanical components were performed. The TLAAs identified for beryllium reflectors and equipment qualification are not included in the TLAAs, but they are covered by other programmes for ageing management. Useful service life for the stainless-steel components of the reactor vessel internals such as grid plates, fasteners, and springs for control rods guide rollers is managed by the AMPs.

Systematic planning and implementation of a multi-disciplinary surveillance programme on the embrittlement of the reactor vessel, considering modelling, measurements, and use of scientific research to ensure compliance with the design requirements was identified by the IAEA team as a **good performance**.

#### **SSCs screening results verification for mechanical SSCs**

The screening of mechanical SSCs for ageing management was performed based on the safety classification. There are some deficiencies in screening of SSCs for ageing management and CSO. Without comprehensive screening, ageing effects of SSCs that are not in scope will not be properly managed, which may have potential operational safety aspects. Lack of documentation of justification of exclusion from scope of SSCs, or non-consideration of potential effects of SSCs

that are not important to safety on those that are important to safety can jeopardize safety. The IAEA team provided a **recommendation** in this area (see *Issue Sheet B-1*).

### **Data collection and record keeping for mechanical SSCs**

A data collection and record keeping system exists within the NRG management system. A management tool (i.e. SAP) initiates a scheduled activity and records its completion. All results of the activities such as maintenance, and inspections performed are recorded currently in the paper format. The IAEA team was informed that format of the relevant records will be modified to link them with the ageing management programme. The approach followed by the facility is generally in line with the IAEA safety standards and no recommendations, suggestions, encouragements, good practices or good performances were identified in this area.

### **Documentation of ageing management in support of CSO for mechanical SSCs**

Documentation for ageing management is available on a Share Point site that contains all related documents, such as the PLAMP, AMPs, TLAAs, and EQ. The approach followed by the facility is generally in line with the IAEA safety standards and no recommendations, suggestions, encouragements, good practices or good performances were identified in this area.

### **Status at follow-up mission**

In this review area, there were two issues presented by the IAEA team in 2022:

- Issue C-1: Shortcomings in the development and implementation of AMPs for some mechanical SSCs;
- Issue C-2: Lack of maintenance programme of spare parts for SSCs important to safety and monitoring of their storage conditions.

In **Issue C-1**, a recommendation was provided that “AMPs for mechanical SSCs should be reviewed and revised, as needed, to ensure that they are in accordance with the ageing management attributes (elements) established by the IAEA safety standards, including ensuring their specificity to the SSCs under consideration covering applicable degradation mechanisms, monitoring, acceptance criteria, and ageing management actions”.

HFR revised in 2022 the equipment qualification programme to update the scope of the programme and then in 2023 to further align with the applicable codes and standards. The latest version of the qualification programme includes a section on harsh conditions caused by postulated initiating events. An evaluation of thermal ageing was performed by HFR and documented in a report. It investigated the possible ageing mechanism for all types of polymeric materials, including rubbers used at HFR. Many existing mechanical AMPs have been reviewed and revised, if incomplete or inconsistent information was found. Additional efforts are needed to determine the appropriate acceptance criteria for many mechanical AMPs.

The efforts that were exerted as well as the established plan for Issue C-1 indicate that the recommendation associated with this issue will be resolved within a reasonable timeframe after the follow-up mission. It is noted that Issue C-1 is relevant to mechanical AMPs, which have a continued nature and need for long-term actions.

### **Conclusion: Satisfactory progress to date for Issue C-1.**

In **Issue C-2**, a recommendation was provided that “A maintenance programme of spare parts for SSCs important to safety should be established, including control and monitoring of the storage conditions”.

HFR has developed a spare parts database for all electrical and I&C SSCs since 2023. A full audit of the spare parts storage against the spare parts database is performed annually. The information

of shelf time is added for newly stored spare parts. Maintenance procedures are under development for spare parts and are to be integrated into a maintenance programme.

**Conclusion: Issue C-2 resolved.**

### 3.4. AGEING MANAGEMENT OF ELECTRICAL AND I&C SSCS

#### **Ageing management review of electrical and I&C SSCs**

The AMR of electrical and I&C SSCs important to safety has generally been performed based on the IAEA safety standards. The IAEA team observed that the analysis and identification of ageing effects for electrical and I&C SSCs important to safety is incomplete, e.g. I&C for the primary core cooling and pool cooling systems. The IAEA team also observed that further investigation is needed on testing of response times of the temperature, flow, pressure and coolant level sensors. During the walkdown of the facility, it was observed that physical separation between some redundant components is not ensured. The IAEA team **suggested** that physical separation between redundant safety channels should be considered in future modernization of the I&C system.

#### **Ageing management programme of electrical and I&C SSCs**

The review of AMPs of electrical and I&C SSCs showed that there are deficiencies in several of them. The IAEA team **recommended** to finalize the AMPs for all in scope electrical and I&C components, ensuring identification of relevant ageing effects, monitoring, and aging management actions. For effective implementation of AMPs, a process should be initiated for identification of cables, and accordingly, installation of proper labelling.

#### **TLAAs and technological obsolescence management for electrical and I&C SSCs**

Useful service life of electrical and I&C SSCs is addressed by maintenance, periodic testing and inspection and is based on the obsolescence management. In the recent years, two safety channels were modernized from use of analogue to digital technology, and modernization of another two is ongoing. Work was also initiated for identification of alternative suppliers for old or obsolete I&C equipment. The IAEA team provided a **recommendation** in this area (see *Issue Sheet A-1*).

#### **SSCs screening results verification for electrical and I&C SSCs**

Screening of SSCs has been performed to identify SSCs in scope for ageing management and CSO. There are some deficiencies in screening of SSCs for ageing management and CSO. Without comprehensive screening, ageing effects of SSCs that are not in scope will not be properly managed, which may have potential operational safety aspects. Lack of documentation of justification of exclusion from scope of SSCs, or non-consideration of potential effects of SSCs that are not important to safety on those that are important to safety can jeopardize safety. The IAEA team provided a **recommendation** in this area (see *Issue Sheet B-1*).

#### **Data collection and record keeping for electrical and I&C SSCs**

It was observed that trending of failure rates of electrical and I&C systems and components is not systematically performed. The team provided a **recommendation** in this area (see *Issue Sheet B-2*).

#### **Documentation of ageing management in support of CSO for electrical and I&C SSCs**

Documentation for ageing management is available on a Share Point site that contains all related documents, such as PLAMP, AMPs, TLAAs, and EQ. The approach followed by the facility is generally in line with the IAEA safety standards and no recommendations, suggestions, encouragements, good practices or good performances were identified in this area.

## Status at follow-up mission

In this review area, there was one issue presented by the IAEA team in 2022:

- Issue D-1: Deficiencies in some AMPs for electrical and I&C SSCs.

In **Issue D-1**, a recommendation was provided that “Development of AMPs should be finalized for all in scope electrical and I&C components, ensuring identification of relevant ageing effects, monitoring, and aging management actions. For effective implementation of AMPs, a process should be initiated for identification of cables, and accordingly, install proper labelling” and a suggestion was provided that “Physical separation between redundant safety channels should be considered in future modernization of the I&C system”.

HFR concluded that the most effective and efficient way to track repeat failures of I&C SSCs is to highlight them at the daily meeting and interrogate SAP as required. Repeated failures of I&C SSCs will be further discussed at the FRACAS meeting, when applicable. All in-scope I&C SSCs are covered in the individual AMPs 2520 – 2580. They are, however, not yet finalized, pending the planned SAR revision. Cabling in the reactor facility has been labelled. Cable identification register was found and have been collated into an Excel spreadsheet. In addition, a comprehensive feasibility study for the separation of redundant nuclear safety channels was performed.

The efforts that were exerted as well as the established plan for Issue D-1 indicate that the recommendation associated with this issue will be resolved within a reasonable timeframe after the follow-up mission. It is noted that Issue D-1 is relevant to electrical and I&C AMPs, which have a continued nature and need for long-term actions.

**Conclusion: Satisfactory progress to date for Issue D-1.**

### 3.5. AGEING MANAGEMENT OF CIVIL SSCS

#### Ageing management review of civil SSCs

AMRs of civil SSCs have been performed in 2014 and reviewed/updated in 2019 to identify service conditions and degradation mechanisms. However, there are shortcomings in the ageing management review of civil structures and components. Without a comprehensive AMR, it cannot be ensured that all degradation mechanisms and their effects will be adequately managed. The IAEA team **recommended** HFR to update the methodology for AMR in accordance with the IAEA safety standards and to perform AMR for all in-scope civil structures and components to ensure that all relevant elements are effectively addressed, including identification of design basis, current condition, degradation mechanisms, and their effects (see *Issue Sheet E-1*).

A study related to leakage of demineralized water from the pools has been performed to determine effects of the leakage on the integrity of the pools’ structure. The IAEA team **suggested** to perform periodical chemical analysis of leaking water from the pools and to utilize the results to improve the ageing management of pools’ structure (see *Issue Sheet E-1*).

#### Ageing management programme of civil SSCs

AMPs have recently been developed to address ageing of civil structures and commodities. AMPs refer to the procedures for activities to minimize, detect, and mitigate ageing effects. Many of these procedures have not yet been developed, although activities may have been ongoing as part of other programmes. There are shortcomings in the development of AMPs for civil structures. Without comprehensive development of AMPs for all in-scope civil structures, effective ageing management cannot be ensured. The IAEA team **recommended** HFR to review and revise AMPs for civil structures, as needed, to ensure that they are in accordance with the ageing management programme attributes (elements) established by the IAEA safety standards, including

identification of condition indicators, acceptance criteria, and ageing management actions (see *Issue Sheet E-2*).

Acceptance criteria are not established or incomplete for several AMPs. The IAEA team provided a **recommendation** in this area (see *Issue Sheet A-2*).

### **TLAAs of civil SSCs**

There is a methodology document for identification of TLAAs. No TLAAs for civil structures have been identified. IGALL TLAAs have been considered not applicable to the HFR civil structures. However, justification has not been provided in the facility documents. No recommendations, suggestions, encouragements, good practices or good performances were identified in this area.

### **SSCs screening results verification for civil SSCs**

Screening of SSCs has been performed to identify SSCs in scope for ageing management and CSO. There are some deficiencies in the screening of SSCs for ageing management and CSO. Without comprehensive screening, ageing effects of SSCs that are not in scope will not be properly managed, which may have potential operational safety aspects. Lack of documentation of justification of exclusion from scope of SSCs, or non-consideration of potential effects of SSCs that are not important to safety on those that are important to safety can jeopardize safety. The IAEA team provided a **recommendation** in this area (see *Issue Sheet B-1*).

### **Data collection and record keeping for civil SSCs**

A data collection and record keeping system exists within the NRG management system. A management tool (i.e. SAP) initiates a scheduled activity and records its completion. All results of the activities such as maintenance, and inspections performed are recorded currently in the paper format. The approach followed by the facility is generally in line with the IAEA safety standards and no recommendations, suggestions, encouragements, good practices or good performances were identified in this area.

### **Documentation of ageing management in support of CSO for civil SSCs**

Documentation for ageing management is available on a Share Point that contains all related documents, such as PLAMP, AMPs, TLAAs, and EQ. The approach followed by the facility is generally in line with the IAEA safety standards and no recommendations, suggestions, encouragements, good practices or good performances were identified in this area.

### **Status at follow-up mission**

In this review area, there were two issues presented by the IAEA team in 2022:

- Issue E-1: Shortcomings in ageing management review of civil structures and components;
- Issue E-2: Shortcomings in the development of AMPs for civil structures.

In **Issue E-1**, a recommendation that “The AMR methodology should be updated in accordance with the IAEA safety standards. The AMRs should be performed for all in-scope civil structures and components to ensure that all relevant elements are effectively addressed, including identification of design basis, current condition, and degradation mechanisms and their effects” and a suggestion that “It is suggested to perform periodical chemical analysis of leaking water from the pools and utilize the results to improve the ageing management of pools’ structure” were raised.

HFR performed condition assessment of HFR building and structures. The identification of degradation mechanisms, however, was performed on a high level, where generic ageing effects

for each construction material (e.g. concrete or steel) are discussed. There is a new AMR procedure, which addresses the AMR process on a high level. The document describes administrative responsibilities and contains the steps in the AMR process in accordance with the IAEA Safety Standards Series No. SSG-48, Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants. However, the implementation of the AMR procedures for the civil AMPs has not been finalized. Periodical chemical analysis of leaking water from the pools has been performed since the main CSO mission. The results are presented to the IAEA team and are utilized to improve the ageing management of pools' structure.

**Conclusion: Satisfactory progress to date for Issue E-1.**

A new suggestion is provided for further guidance to ensure resolution of Issue E-1 within a reasonable timeframe:

S) HFR should consider performing specific AMRs for in-scope structures and components that may be organized in commodity groups based on similarities in their functions, materials, and environment. It is also suggested to prioritize structures and components subjected to the degradation mechanisms that can potentially result in the degradations having a greater safety consequence, e.g., foundations and pools.

In **Issue E-2**, a recommendation that “AMPs for civil structures and components should be reviewed and revised, as needed, to ensure that they are in accordance with the ageing management attributes (elements) established by the IAEA safety standards, including identification of condition indicators, acceptance criteria, and ageing management actions” was raised.

HFR is currently reviewing the civil AMPs with a focus on the accuracy and completeness of their contents, including titles, scopes, interfaces/boundaries, materials, service conditions, degradation mechanisms, and applied ageing management strategies. There is also an intent to cross reference the AMPs, so that their interface can be addressed. References to the procedures for activities to minimize, detect, and mitigate ageing effects are being included in the updated AMPs. Activities to identify the condition indicators and to determine the acceptance criteria and corrective actions are being performed. The intent is to include the acceptance criteria in the procedures cross referencing the associated AMPs and specific documents describing the justifications for the acceptance criteria.

The efforts that were exerted as well as the established plan for Issue E-2 indicate that the recommendation associated with this issue will be resolved within a reasonable timeframe after the follow-up mission. It is noted that Issue E-2 is relevant to civil AMPs, which have a continued nature and need for long-term actions.

**Conclusion: Satisfactory progress to date for Issue E-2**

#### 4. OVERVIEW OF RECOMMENDATIONS AND SUGGESTIONS

Issue No.	Fundamental Overall Problem	Rec.	Sugg.
<b>Review Area A: Organization of ageing management and continued safe operation activities</b>			
A-1	The obsolescence management programme needs to be further developed and systematically implemented.	1	-
A-2	Acceptance criteria are not established or incomplete for several AMPs	1	-
<b>Review Area B: Screening of SSCs and reactor programmes</b>			
B-1	The screening methodology does not cover SSCs that are not important to safety, but their failure may prevent those important to safety from performing their intended safety functions. The scope of SSCs for ageing management and CSO does not cover all SSCs important to safety	1	-
B-2	Missing procedures on managing SSCs master list, walkdown, and ensuring interaction of ageing management with the other plant operating programmes can affect the effective implementation of the PLAMP	1	-
<b>Review Area C: Ageing management of mechanical SSCs</b>			
C-1	Some AMPs of mechanical SSCs do not systematically incorporate the attributes of ageing management and include incomplete or generic information, and some inconsistencies exist	1	-
C-2	There is no maintenance programme of spare parts for SSCs important to safety established, and storage conditions of the spare parts are not controlled nor monitored	1	-
<b>Review Area D: Ageing management of electrical and I&amp;C SSCs</b>			
D-1	There is a need to complete the development of AMPs for several electrical and I&C SSCs, and to ensure inclusion of ageing effects, monitoring and management actions in all relevant programmes	1	1
<b>Review Area E: Ageing management of civil SSCs</b>			
E-1	Ageing management review is not performed in a comprehensive manner for ageing management of civil structures and components	1	1
E-2	AMPs of civil SSCs do not systematically incorporate the attributes (elements) of effective ageing management programme	1	-

The complete set of Issue Sheets is presented in Appendix I of this report.

## 5. DEFINITIONS

### **Recommendation**

A recommendation is a proposal for changes to assure alignment with the IAEA Fundamental Safety Principles and safety requirements.

### **Suggestion**

A suggestion is a proposal for changes to better meet the IAEA safety requirements and safety guides.

### **Encouragement**

If an item does not have sufficient safety significance to meet the criteria of a recommendation or suggestion, but the expert or the team feels that mentioning it still desirable, the given topic may be described in the text of the report using the phrase encouragement.

### **Good Performance**

A good performance is a superior objective that has been achieved or a good technique or programme that contributes directly or indirectly to operational safety and sustained good performance, that works well at the facility. However, it might not be necessary to recommend its adoption by other research reactors, because of financial considerations, differences in design or other reasons.

### **Issue resolved**

All necessary actions have been taken to deal with the root causes of the recommendation rather than to address each individual fact identified by the team. A management review has been carried out to ensure that actions taken have eliminated the root cause. Actions have also been taken to check that it does not recur. Alternatively, the issue is no longer valid due to, for example, changes in the hosting organization.

### **Satisfactory progress to date**

Actions have been taken, including root cause determination, which lead to a high level of confidence that the recommendation will be resolved within a reasonable timeframe, after the follow-up mission. These actions might include budget commitments, staffing, document preparation, increased or modified training, equipment purchases, etc. This category implies that the recommendation could not reasonably have been resolved prior to the follow-up visit, either due to its complexity or the need for long-term actions. This category also includes recommendations, which have been resolved using temporary or informal methods, or when resolution has only recently taken place and its effectiveness has not been fully assessed.

### **Insufficient progress to date**

Actions taken or planned do not lead to the conclusion that the issue will be resolved within a reasonable timeframe. This category includes issues in response to which no action has been taken.

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- [22] Specific AMPs (AMP 100 – AMP 4000), Updated by 16-6-2022, (2022).
- [23] Organogram NO-HFR, NO-IB-FHR-OD-0016 (Ver. 1.0), (2018).
- [24] Evaluation report Safety factor 2 – 4 as part of periodic safety review HFR 2014-2020, NRG-25259/22.233163 C&S, (2022).
- [25] Advance Information Package (AIP), HFR, (2020).
- [26] Additional Information to Advance Information Package (AIP), HFR, (2022).
- [27] Technical presentations during CSO Mission, HFR, (2022).
- [28] NO-IB-VE-BD-020392, Plant Level Ageing Management Program HFR (rev. 2), 25/06/2024.
- [29] NRG-25245/20.179815, Technological Obsolescence Program HFR (2nd version), 27/09/2023.
- [30] NO-IB-VE-BD-022149, HFR Corrective Action Program (2nd version), 26/09/2023.

- [31] NO-IB-VE-BD-020684, Equipment Qualification Program (rev.3), 20/10/2023.
- [32] 2.5245.40/23.261944, PPO Acceptance Criteria Methodology, 30/08/2023.
- [33] NO-IB-VE-PD-021490 Ageing Management Review Procedure (2022).
- [34] NO-IB-VE-OD-021358 Walkdown for Ageing Management - Guidelines and checklist (2022).
- [35] Advance Information Package (AIP), HFR, (2024).
- [36] Additional Information to Advance Information Package (AIP), HFR, (2024).
- [37] Technical presentations during CSO Mission, HFR, (2024).

## 7. TEAM COMPOSITIONS

### 7.1. IAEA TEAM FOR THE MAIN MISSION

<b>IAEA STAFF MEMBER:</b>		
<b>Amgad Shokr</b>	Team Leader	IAEA, NSNI, SH-RRSS
<b>Kaichao Sun</b>	Deputy Team Leader	IAEA, NSNI, RRSS, Nuclear Safety Officer
<b>Gabor Petofi</b>	Team Member	IAEA, NSNI, OSS, Senior Nuclear Safety Officer
<b>IAEA EXTERNAL EXPERTS:</b>		
<b>Nestor De Lorenzo</b>	Reviewer A/B	Argentina
<b>Deshraju Rao</b>	Reviewer C	India
<b>Charles Morris</b>	Reviewer D	Australia
<b>Julia Tchermer</b>	Reviewer E	Canada

### 7.2. HFR TEAM FOR THE MAIN MISSION

<b>HFR COUNTERPARTS:</b>		
<b>Onne Wouters</b>	Main Counterpart	Reactor Manager
<b>Ledia Hasa</b>	Area A	Ageing Management Coordinator
<b>Lorenzo Stefanini</b>	Area B	Maintenance Manager
<b>Frederic Blom</b>	Area C	Cluster Manager for Nuclear Compliance and Projects
<b>Jan Waard</b>	Area D	Senior E&I Engineer
<b>Ciska de Haan</b>	Area E	Team Leader for Asset Integrity Services
<b>ADDITIONAL HFR STAFF:</b>		
<b>Johan Best</b>	Area E	Nuclear Safety Manager
<b>Ryno Nel</b>	Area A/B	Engineering Manager
<b>Louis Jacobs</b>	Area C	Senior Reactor Engineer
<b>Luca Ratti</b>	Area D	CSO Consultant

### 7.3. ANVS PARTICIPANTS (OBSERVERS)

<b>Ramon Muller</b>	Site Inspector
<b>Arnout Koppert</b>	Deputy Site Inspector
<b>Wilma Tolud</b>	Inspector Human and Organizational Factors

#### 7.4. IAEA TEAM FOR THE FOLLOW-UP MISSION

<b>IAEA STAFF MEMBER:</b>		
<b>Kaichao Sun</b>	Team Leader	IAEA, NSNI, RRSS, Nuclear Safety Officer
<b>IAEA EXTERNAL EXPERTS:</b>		
<b>Jason Chakovski</b>	Reviewer B/D	Australia
<b>Julia Tcherer</b>	Reviewer E	Canada

#### 7.5. HFR TEAM FOR THE FOLLOW-UP MISSION

<b>HFR COUNTERPARTS:</b>		
<b>Ryno Nel</b>	Main Counterpart	Reactor Manager
<b>Ledia Hasa</b>	Area A	Ageing Management Coordinator
<b>Ledia Hasa</b>	Area B	Ageing Management Coordinator
<b>Steve van Doorene</b>	Area A/B	CSO Project Manager
<b>Frederic Blom</b>	Area C	Cluster Manager for Nuclear Compliance and Projects
<b>Lance Davis</b>	Area D	Engineering Manager
<b>Ledia Hasa</b>	Area E	Ageing Management Coordinator
<b>ADDITIONAL HFR STAFF:</b>		
<b>Johan Best</b>	Area A/B	Nuclear Safety Manager
<b>Louis Jacobs</b>	Area C	Senior Reactor Engineer
<b>Antonio Piccolo</b>	Area C	Reliability Engineer
<b>Herman Visagie</b>	Area D	E&I Engineer
<b>Patrick Haarsma</b>	Area D	E&I Engineer
<b>Wesley Jarvis</b>	Area E	Civil Engineer
<b>Emiel Drenth</b>	Area D/E	CSO Consultant

## APPENDIX I. ISSUE SHEETS

<b>1. ISSUE IDENTIFICATION</b>	<b>Issue Number: A-1</b>
<b>Research reactor: HFR</b>	
<b>Reviewed Area: Organization of ageing management and continued safe operation activities</b>	
<b>1.1 – ISSUE TITLE:</b> Incomplete obsolescence management programme	
<b>1.2 – FUNDAMENTAL OVERALL PROBLEM:</b> The obsolescence management programme needs to be further developed and systematically implemented	
<b>2. ASSESSMENT OF THE STATUS</b>	<b>Date: 24/06/2022</b>
<b>2.1 – FACTS:</b> <b>F1)</b> In addition to the implementation, along the past several years, of significant activities to deal with ageing of SSCs, the HFR developed a PLAMP in 2020. An obsolescence management programme, as a component of the PLAMP, was developed in 2022 and, at present, is in an early stage of implementation. <b>F2)</b> The screening of SSCs across mechanical, electrical, I&C, and civil areas for obsolescence is not yet conducted in a consistent manner. <b>F3)</b> For SSCs important to safety, the HFR has not yet considered all obsolescence management actions that are established by the IAEA Safety Standards No SSG-10 (i.e. identification of useful service life with foresight and anticipation, preparation of modification projects, provision of spare parts, or identification of alternative suppliers). <b>F4)</b> There is no formal training of the staff on the implementation of the obsolescence management programme.	
<b>2.2 – SAFETY CONSEQUENCE:</b> Without the fully developed procedures for obsolescence management and the systematic and complete implementation of the programme, the availability and the reliability of the SSCs for performing their intended safety functions can be jeopardized. Without training of staff, the efficiency and effectiveness of implementation of the programme cannot be ensured.	
<b>2.3 – RECOMMENDATION/SUGGESTION:</b> <b>R)</b> Systematic implementation of the obsolescence management programme should be ensured, including among others by establishing procedures considering all relevant management actions that are recommended by the IAEA Safety Standards No SSG-10. A formal training programme should be established for the involved HFR staff across the mechanical, electrical, I&C, and civil areas, to ensure the effectiveness in the implementation of the programme.	
<b>2.4 – IAEA BASIS:</b> <ul style="list-style-type: none"> <li>– SSR-3: Requirement 37</li> <li>– SSG-10: para. 3.1, 3.7,3.10, 4.20 and Section 6</li> <li>– SSG-48: para. 2.3-2.5, 2.25- 2.29, 3.20- 3.21, 4.5, Section 6, para. 7.3</li> <li>– SSG-37: para. 8.5, 9.2, 10.1 and 10.7</li> <li>– NS-G-4.2: para. 5.25</li> <li>– SRS-99: Safety Factor 2, Safety factor 4 and Safety Factor 7</li> </ul>	

<b>2.5 – DOCUMENTS REVIEWED:</b>	
<ul style="list-style-type: none"> <li>– K6150/18.151275 NO-HFR/MK/IW, Obsolescence management, 21/12/2018</li> <li>– NO-IB-VE-OD-020797, Hulpmiddel obsolescence gesprek, 29/04/2022</li> <li>– Major events which occurred at HFR 2008-2022, AIP</li> <li>– NRG-25245/20.117523, Plant Level Ageing Management HFR, 04/08/2020</li> </ul>	
<b>3. COUNTERPART ACTIONS TO RESOLVE ISSUE</b>	<b>Date: 30/05/2024</b>
<b>3.1 – RESULTS OF THE ISSUE ANALYSIS:</b>	
<p>Several actions have been undertaken to resolve the noted deficiencies in the obsolescence management programme. A formal training module has been added to the NRG training platform, which is accessible to all HFR staff. This training focusses on effective obsolescence management by highlighting the roles and responsibilities of all stakeholders involved with the programme. The obsolescence procedures have been further developed to ensure the systematic implementation of the obsolescence programme. Lastly, identification of potentially obsolete components, by means of a scoping and screening process of all HFR SSCs, is still ongoing.</p>	
<b>3.2 – CORRECTIVE ACTIONS:</b>	
<ol style="list-style-type: none"> <li>1) Develop a formal training module for maintenance technicians, system engineers and operators to develop their knowledge and awareness related to non-physical ageing of components (i.e. obsolescence).</li> <li>2) Assign a dedicated malfunctioning category in SAP related to obsolescence. Review and revise the obsolescence procedure in order to bring it in alignment with SSG-10. This includes the steps to follow in order to conduct proactive obsolescence monitoring of components and accordingly take action to resolve the obsolescence issue.</li> <li>3) Develop the Technological Obsolescence Program as an HFR Plant Programme in accordance with the SSG-10, including the scope and screening process for all SSCs.</li> </ol>	
<b>3.3 – STATUS OF CORRECTIVE ACTIONS IMPLEMENTATION:</b>	
<ol style="list-style-type: none"> <li>1) The training module has been created, with formal instruction to the HFR staff including maintenance, engineering and operation departments still is ongoing. The training can be found as ‘Verouderingsbeheer’ in the LuMoS catalogue. This training aims to increase the effectiveness of the ageing management program within the HFR organization and discussed relevant documentation and procedures related the HFR obsolescence program. Successful completion of this training module is registered on LuMos under the employee’s personal profile.</li> <li>2) A dedicated obsolescence category (N2) has been introduced in the HFR issue reporting database (SAP), used for registering and monitoring the status of technical deviations on the plant. The review and update of the obsolescence procedure for obsolescence-reporting has been finalized and is available on the Management System: NO-IB-VE-PD-021212.</li> <li>3) The Technological Obsolescence Programme has been developed and is available on the Management System: NO-IB-VE-OD-020683. The management of obsolescence of SSCs important for safe and/or reliable reactor operation and the spare parts required to maintain those SSCs is described in the TOP. Additionally, the scoping and screening process for all SSCs has been included.</li> </ol>	
<b>4. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM</b>	<b>Date: 03/07/2024</b>
<b>4.1 – FACTS:</b>	
<p><b>F1)</b> The Technological Obsolescence Programme, developed for HFR in August 2022, was revised in September 2023. An approach of the scope and screening process for the</p>	

obsolescence management was described in the programme. The screening was implemented systematically to all in-scope SSCs using the SCsML, but a separate database was created;

**F2)** The IAEA team verified the database using for obsolescence screening, where about 40% of SSCs have been completed. During the screening process, photos were added in the database and the information on the spare parts was included (also see Issue Sheet C-2);

**F3)** HFR assigned a dedicated malfunctioning category in SAP related to obsolescence (N2). The revised obsolescence procedure includes the steps to conduct monitoring and take action to resolve identified issues. About 30 actions were planned in a log file and they were gradually being implemented over the past two years, including a recent implementation in June 2024, the week before the follow-up mission;

**F4)** HFR was tracking the human resource allocated to the systematic implementation of the obsolescence programme. It recorded nearly 12,000 staff-hours, as of the follow-up mission;

**F5)** A formal training module for relevant HFR staff, including maintenance technicians, system engineers and reactor operators, has been developed for ageing management, including obsolescence management. The training records are registered under the staff's personal profile.

**4.2 – DOCUMENTS REVIEWED:**

- NRG-25245/20.179815, Technological Obsolescence Program HFR (2nd version), 27/09/2023;
- NO-IB-VE-PD-021212, Obsolescence procedure (N2 melding), Version 3.0, 01/06/2022;
- HFR Obsolescence Database and a log file summarizing actions;
- Trainings Details (Verouderingsbeheer), LuMoS, NRG HFR.

**4.3 – RESOLUTION DEGREE:**

<b>1.</b>	<b>Insufficient progress to date</b>	
<b>2.</b>	<b>Satisfactory progress to date</b>	
<b>3.</b>	<b>Issue resolved</b>	X

<b>1. ISSUE IDENTIFICATION</b>	<b>Issue Number: A-2</b>
<b>Research reactor: HFR</b>	
<b>Reviewed Area: Organization of ageing management and continued safe operation activities</b>	
<b>1.1 – ISSUE TITLE:</b> Deficiencies in acceptance criteria for ageing management programmes	
<b>1.2 – FUNDAMENTAL OVERALL PROBLEM:</b> Acceptance criteria are not established or incomplete for several AMPs	
<b>2. ASSESSMENT OF THE STATUS</b>	<b>Date: 24/06/2022</b>
<b>2.1 – FACTS:</b> <b>F1)</b> Individual AMPs have been developed for commodity groups of HFR SSCs. Some of these AMPs (or the procedures referenced thereof) are lacking acceptance criteria, and some others include inappropriate acceptance criteria. ( <i>See Issue Number C-1, and Issue Number E-2</i> ). <b>F2)</b> The acceptance criteria in many AMPs that were reviewed and discussed during the mission were not based on the design basis for items important to safety or on the technical requirements for the SSCs.	
<b>2.2 – SAFETY CONSEQUENCE:</b> Lack of clear acceptance criteria in SSCs ageing management programme may preclude the timely implementation of preventive or mitigatory ageing management actions. The Safety of the facility could be affected unless preventive measures are implemented, and timely appropriate corrective actions.	
<b>2.3 – RECOMMENDATION/SUGGESTION:</b> <b>R)</b> Appropriate acceptance criteria should be established for all AMPs, thus supporting the timely identification and implementation of necessary ageing management actions. Such criteria should be established based on design basis, technical requirements, applicable codes and standards, and considering availability of sufficient safety margins.	
<b>2.4 – IAEA BASIS:</b> <ul style="list-style-type: none"> <li>– SSR-3: Requirement 17, para. 6.24 and 7.69</li> <li>– SSG-10: para. 3.3</li> <li>– SSG-48: Section 2, para. 5.25, 5.47 and 5.52</li> <li>– NS-G-4.2: para. 1.5, 3.5 and 8.1</li> <li>– SRS-99: Safety factor 4</li> </ul>	
<b>2.5 – DOCUMENTS REVIEWED:</b> <ul style="list-style-type: none"> <li>– NRG-25245/20.117523, Plant Level Ageing Management HFR, 04/08/2020</li> <li>– AMP 800 -Piping- PIP-CW-0-2, 2020</li> <li>– AMP 810 -Piping- PIP-CW-1-0, 2021</li> <li>– AMP 820 -Piping- PIP-UW-1-2, 2021</li> <li>– AMP 170 -Horizontal beam tubes- HBS-CW/AG-1-0</li> </ul>	
<b>3. COUNTERPART ACTIONS TO RESOLVE ISSUE</b>	<b>Date: 30/05/2024</b>
<b>3.1 – RESULTS OF THE ISSUE ANALYSIS:</b> The AMPs are being reviewed in accordance with SSG-10 Rev.1 to ensure components have been assigned suitable acceptance criteria, if/where applicable. Where required, acceptance	

criteria are defined and recorded in the respective maintenance procedures and operational procedures. For the electrical and I&C components, a project has been initiated to establish the respective acceptance criteria.

**3.2 – CORRECTIVE ACTIONS:**

- 1) Review and revise AMPs for Mechanical, Electrical and Civil SSCs, to ensure acceptance criteria for all components are assigned. Where needed, initiate actions to incorporate acceptance criteria in the applicable maintenance or operational procedures.
- 2) Define acceptance criteria related to tolerances, uncertainties and drift parameters for electrical and I&C components in the maintenance and operational procedures.
- 3) Update the maintenance and operational procedures to include the new/revised acceptance criteria.

**3.3 – STATUS OF CORRECTIVE ACTIONS IMPLEMENTATION:**

- 1) The review of AMPs including the acceptance criteria is being performed and is nearing completion for mechanical components. The establishment of acceptance criteria for Civil AMPs, where applicable, is ongoing. Acceptance criteria have been developed for the building settlement (see note: 2.5245.50.24.284916). The associated civil maintenance procedure will be revised accordingly.
- 2) Electrical AMPs are being reviewed and updated to ensure that ageing of all electrical SSCs is managed. To assist with this, a methodology to define applicable acceptance criteria for components has been developed and is described in NRG Note 2.5245.40/23.261944. The note distinguishes between two types of instruments that undergo regular field calibrations:
  - Calibration Type 1: Instruments for which an absolute value of the measurement uncertainty is important. These instruments typically perform important safety functions (e.g. instruments forming part of the reactor protection system) or are used to evaluate safety limits contained in the VTS (e.g. water chemistry sensors, or radiation monitors).
  - Calibration Type 2: Instruments for which reliable operation are more important than absolute accuracy (e.g. primary pump outlet pressure).
 Classification (type 1 or 2) of the maintenance procedures is further described in NRG Note 2.5245.40/23.265477 Rev 2. Following the classification process, a set of reports describing, for each Type 1 instrument and each Calibration Group, the justification and calculation of the new calibration tolerance, drift tolerance and measurement uncertainty values, is provided.
- 3) The abovementioned reports will be used as the basis to update the relevant PPOs, available on the Management System.

<b>4. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM</b>	<b>Date: 03/07/2024</b>
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**4.1 – FACTS:**

**F1)** A methodology to establish acceptance criteria for periodic preventative maintenance (PPOs) of electrical and I&C SSCs was developed in August 2023. The methodology is primarily applicable to instruments subjected to regular field calibrations. Examples to determine the instrument calibration and drift tolerances as well as the detailed uncertainties were provided;

**F2)** Acceptance criteria for the several civil SSCs have also been investigated. For example, the differential settlement between buildings was identified to be the key factor to be assessed for the ageing management of the reactor foundation (i.e. AMP 904). Condition assessments of HFR building and structures was performed and documented (see also Issue Sheet E-1). It is determined that when any differential settlement between buildings is greater

than 5 mm, an inspection of the area needs to be conducted. No corrective actions were established under such circumstances. Another example is that the condition assessment was also performed to analyse the chemical compositions for the leaking water from the reactor pool. The leakage rate was also measured and was used to establish an acceptable total leak rate applicable to all leak paths from the pool structure, which is several times higher than current leakage rate;

**F3)** During the follow-up mission, the IAEA explained the importance of referencing not only the results of conditional assessment, but also the design basis of in-scope SSCs for the development the acceptance criteria in AMPs. Such information can be obtained from similar (nuclear) installations being constructed in the region.

**F4)** Efforts have been made on establishing the acceptance criteria for few AMPS (e.g. AMP 904 for Civil: Foundation), but most other AMPs still do not include clear specifications of acceptance criteria.

**F5)** In some newly developed AMPs (e.g. AMP 909 – DM Cell Structure and AMP 710 – Hijsmiddelen), the acceptance criteria was referred to the HFR Corrective Action Program, which describe the overall process of the Program, but not include any specific acceptance criteria for SSCs important to safety. In some other AMPs, acceptance criteria were noted as not applicable (N/A). In general, the acceptance criteria in HFR AMPs were found without clear specifications and need further improvements.

#### **4.2 – DOCUMENTS REVIEWED:**

- 2.5245.40/23.261944, PPO Acceptance Criteria Methodology, 30/08/2023;
- 2.5245.50/24.284916, HFR Buildings: Building Settlement – Trending and Acceptance Criteria, 1st Issue, 30/05/2024;
- NO-IB-VE-OD-020394, AMP 110 – Nuclear: Reactor Vessel (2nd Version), 01/06/2024;
- NO-IB-VE-OD-020671, AMP 800 – Piping (3rd version), 26/06/2024;
- NO-IB-VE-OD-020660, AMP 901 – Civil: Containment Steel (3rd version), 25/06/2024;
- NO-IB-VE-OD-020663, AMP 904 – Civil: Foundation (3rd version), 25/06/2024;
- NO-IB-VE-OD-022249, AMP 909 – DM Cell Structure (1st version), 16/11/2023;
- AMP 710 – Hijsmiddelen (Hoisting Equipments), draft;
- NO-IB-VE-BD-022149, HFR Corrective Action Program (2nd version), 26/09/2023.

#### **4.3 – RESOLUTION DEGREE:**

<b>1.</b>	<b>Insufficient progress to date</b>	X
<b>2.</b>	<b>Satisfactory progress to date</b>	
<b>3.</b>	<b>Issue resolved</b>	

A new recommendation is provided for further guidance for resolving Issue A-2:

**R)** Appropriate acceptance criteria for the inspection and monitoring of ageing effects on in-scope SSCs should be further developed based on the design basis for items important to safety or on the technical requirements for the structure or component, as well as on the relevant regulatory requirements, codes and standards, so that a corrective action can be implemented before loss of the intended function of the structure or component.

<b>1. ISSUE IDENTIFICATION</b>	<b>Issue Number: B-1</b>
<b>Research reactor: HFR</b>	
<b>Reviewed Area: Screening of SSCs and reactor programmes</b>	
<b>1.1: ISSUE TITLE: Deficiencies in screening of SSCs for ageing management and CSO</b>	
<b>1.2: FUNDAMENTAL OVERALL PROBLEM:</b>	
<p>The screening methodology does not cover SSCs that are not important to safety, but their failure may prevent those important to safety from performing their intended safety functions. The scope of SSCs for ageing management and CSO does not cover all SSCs important to safety.</p>	
<b>2. ASSESSMENT OF THE STATUS</b>	<b>Date: 24/06/2022</b>
<b>2.1 – FACTS:</b>	
<p><b>F1)</b> Structures and Components Master List (SCsML) is used as the main input to define the scope of the reactor SSCs for ageing management and CSO. This list is derived from the facility asset register (i.e. SSCs with an identification number) and is complemented by adding SSCs without identification number (e.g. pipes), those identified during walkdowns (e.g. electrical cabinets), and those identified in previously developed documents (e.g. AMR, 2014). <i>(See also Issue Sheet B-2 on the need to improve the effectiveness of walkdowns for ageing management purposes).</i></p> <p><b>F2)</b> Although the facility documents claim that SSCs that are classified as Safety Class 1, 2, and 3 are covered by the scope, not all SSCs important to safety are in the scope; for example, the hot cell (except ventilation parts), Building 117 structures, and a section of a buried pipe.</p> <p><b>F3)</b> Some SSCs are only covered by the maintenance programme but are not in scope of ageing management. For example, the load handling equipment (except cranes) such as chain pulley blocks are not covered by the scope.</p> <p><b>F4)</b> SSCs that are classified as not important to safety were not considered in the scope (some were recently introduced for reliability improvement purposes). Failure (or ageing) of some of them could prevent SSCs important to safety from performing their intended safety function.</p> <p><b>F5)</b> The justification of exclusion of the SSCs that are “out of scope” is not described in the facility documents; for example exclusion of containment insulation.</p>	
<b>2.2 – SAFETY CONSEQUENCE:</b>	
<p>Ageing effects of SSCs that are not in scope will not be properly managed, which may have potential operational safety aspects. Lack of documentation of justification of exclusion from scope of SSCs, or non-consideration of potential effects of SSCs that are not important to safety on those that are important to safety can jeopardize safety.</p>	
<b>2.3 – RECOMMENDATION/SUGGESTION:</b>	
<p><b>R)</b> The screening methodology should be further aligned with the IAEA safety standards by including items that are not important to safety but their failure may prevent SSCs important to safety from performing their intended safety functions. The scope for ageing management and CSO should be expanded to cover all the SSCs classified as Safety Class 1, 2, and 3.</p>	

**2.4 – IAEA BASIS:**

- SSR-3: Requirement 86
- SSG-10: para. 2.13, 3.12, 5.2, 5.4- 5.8 and 7.6
- SSG-48: para. 2.12, 2.32, 3.11, 4.48, 5.14-5.21, 5.25 and 5.34
- NS-G-2.13: para. 3.1 and 3.9
- SRS-99: Safety factor 2, Safety factor 4 and Safety factor 7

**2.5 – DOCUMENTS REVIEWED:**

- Plant Level Ageing Management HFR, 2020
- Structures and Components Master List, Excel Sheet
- Safety Analysis Report, HFR
- AMP 170 -Horizontal beam tubes- HBS-CW/AG-1-0
- AMP 800 -Piping- PIP-CW-0-2, 2020
- AMP 810 -Piping- PIP-CW-1-0, 2021
- AMP 820 -Piping- PIP-UW-1-2, 2021
- AMP 906, NO-IB-VE-OD-020665, Structural Elements (2022);
- AMP 907, NO-IB-VE-OD-020666, Doors Sealing (2022);
- AMP 908, NO-IB-VE-OD-020667, Hall Spray and Ventilation (2022);
- AMP 910, NO-IB-VE-OD-020668, Pools (2022);
- Results of walkdown

**3. HOSTING ORGANIZATION ACTIONS TO RESOLVE ISSUES****Date: 30/05/2024****3.1 – RESULTS OF THE ISSUE ANALYSIS:**

Several actions have been undertaken with the aim of improving the screening methodology. This includes the development of procedures to ensure the effectiveness of the screening methodology, which includes consideration of SSCs that are not important to safety. Inconsistent or missing safety classifications were identified in electrical and civil SSCs and the screening methodology was applied to these SSCs.

The revised safety classifications have been added to the Master list, available on the documentation Management System, and the specific AMPs are being updated accordingly as part of the review. Procedures to update and record the Master List's gap analysis have been developed and formalized, including the development of a walkdown guideline and checklist.

As recommended, three SSCs have been added to the scope of the relevant AMPs, namely (1) DM hot cell, (2) lifting equipment and (3) containers owned by the HFR. Inclusion of the cabinets, cables, civil and piping in the official asset register is being considered. Specific AMPs and the Master List have been reviewed and are currently being revised to include the main safety function of the SSCs in agreement with the HFR SAR.

**3.2 – CORRECTIVE ACTIONS:**

- 1) Revise the scope methodology described in the PLAMP, to include consideration of SSCs that are not important to safety.
- 2) Review/define the safety classification of I&C and Civil SSCs by using the classification methodology, as described in SAR Chapter 4.
- 3) Develop specific AMPs for the safety classified SSCs not included in the scope of the ageing management programme.

- 4) Include the main safety functions of the SSCs in the Master List, in accordance with the relevant SAR chapter.
- 5) Review the relevance of the reliability of all SSCs, safety related and non-safety related. Add the identified SSCs to the scope of the relevant AMP.
- 6) Develop a walkdown guideline and checklist to ensure effective ageing management by identifying possible changes to the scope of the AMPs, assessing the overall condition of SSCs to pre-emptively identify possible changes in relevant ageing mechanisms and management strategies.
- 7) Develop a procedure to perform frequent gap analyses to the Master List, which should include all the resources necessary for the gap analysis.
- 8) Develop a procedure for encoding and labelling piping.
- 9) Improve the functionality of the cable list by converting it from a Word-document to an Excel-database.

### **3.3 – STATUS OF CORRECTIVE ACTIONS IMPLEMENTATION:**

- 1) The PLAMP is being updated and will contain an amended scope methodology to also include components that are not important to safety.
- 2) The safety classification for I&C components has been completed and recorded in the Master List. Efforts are ongoing to review/revise the safety classification of Civil SSCs and to supplement the Asset register with the revised safety classification.
- 3) The ageing management programme is being expanded to include all safety related SSCs. Examples include AMP 180 - Containers, AMP 710 – lifting equipment and AMP 909 - DM cell.
- 4) Safety functions of in-scope SSCs have been included in the Master List and updated versions of the AMPs will include and describe the main safety functions of the SSCs.
- 5) The reliability review for electrical components have been completed. Electrical AMPs will be amended to include a list of reliability related SSCs, where applicable. This review and associated amendments is still to be initiated for mechanical components.
- 6) The walkdown guideline and checklist has been finalized and is available on the Management System (NO-IB-VE-OD-021358).
- 7) The procedure (NO-IB-VE-PD-021465) for performing the gap analysis on the Master List has been developed and is available on the Management System. A template (NO-IB-VE-OD-021473) for the gap analysis has been developed to record the outcome.
- 8) The procedure for encoding and labelling of piping is available in the Management System (NO-IB-VE-OD-022131) and provides instruction on how to assign a unique and recognizable code to the pipelines. The implementation of this procedure is currently on-hold due to resource constraints, but will be considered in the future. The HFR Pipeline list (Excel-template NO-IB-VE-OD-022306) has been developed to register the labelled pipe.
- 9) The cable list has been converted to an Excel-list, which improves the usability of the data and is managed by the HFR drawing office.

## **4. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM**

**Date: 03/07/2024**

### **4.1 – FACTS:**

**F1)** Safety Class 1 for HFR includes all SSCs directly contributing to a safety function during normal operation and accident conditions; Safety Class 2 for HFR includes all SSCs whose failure causes escalation of an anticipated operational occurrence to a PIE/DBA or SSCs which support one or more Safety Class 1 SSCs; Safety Class 3 SSCs contribute to prevention or mitigation of design extension conditions.

**F2)** The HFR screening to determine in-scope SSCs for ageing management follows the safety classes, rather than the recommended screening process outlined in IAEA Safety Standards Series No. SSG-10 (Rev.1), Ageing Management for Research Reactors. Nevertheless, it is of the IAEA team’s opinion that the currently adopted screening process can also effectively setup the scope ageing management and CSO at HFR.

**F3)** The methodology for screening of SSCs has been further revised in the PLAMP to include a feedback loop for SSCs considered not important to safety, but their failure can result in a decrease in reliability. All electrical SSCs have been screened for reliability, using the new screening process. Mechanical SSCs are still in progress. Civil SSCs are currently being screened for their safety classes. For example, the security entrance building (i.e. Building 112), has been determined as Safety Class 2 and it is thus in-scope for the ageing management programme.

**F4)** Additional AMPs were drafted after the main mission, for SSCs were identified as in-scope, but were not in place previously. These include, for example, AMP 180 (Containers), AMP 710 (Hoisting Equipment), and AMP 909 (DM cell);

**F5)** A comprehensive walkdown procedure has been developed to support the screening process (see Issue Sheet B-2).

**F6)** A procedure for performing the gap analysis on the SCsML has been developed and is available in the management system.

**4.2 – DOCUMENTS REVIEWED:**

- NO-IB-VE-BD-020392, Plant Level Ageing Management Program HFR (rev. 2), 25/06/2024;
- AMP 180: Containers (draft);
- AMP 909: DM Cell (draft);
- AMP 710: Hoisting Equipment (draft);
- NO-IB-VE-OD-021473, Template Gap Analysis;
- NO-IB-VE-PD-021465, Gap Analysis Procedure.

**4.3 – RESOLUTION DEGREE:**

<b>1.</b>	<b>Insufficient progress to date</b>	
<b>2.</b>	<b>Satisfactory progress to date</b>	
<b>3.</b>	<b>Issue resolved</b>	X

<b>1. ISSUE IDENTIFICATION</b>	<b>Issue Number: B-2</b>
<b>Research reactor: HFR</b>	
<b>Reviewed Area: Screening of SSCs and reactor programmes</b>	
<b>1.1 – ISSUE TITLE:</b> Need to further improve the effective implementation of the PLAMP	
<b>1.2 – FUNDAMENTAL OVERALL PROBLEM:</b> Missing procedures on managing SSCs master list, walkdown, and ensuring interaction of ageing management with the other plant operating programmes can affect the effective implementation of the PLAMP.	
<b>2. ASSESSMENT OF THE STATUS</b>	<b>Date: 24/06/2022</b>
<b>2.1 – FACTS:</b> <b>F1)</b> The PLAMP includes framework on managing the interaction (interface) of ageing management and the plant operating programmes and documentation such as maintenance, inspection, surveillance, modification, safety analysis, and safety analysis report. The PLAMP is also supported by tens of specific AMPs. The PLAMP and AMPs were approved between 2020 and 2022. Some AMPs are being implemented and the facility’s documents mentioned above are being updated. Management of the interaction between the AMPs and the plant operating programmes and documents is not supported by procedures. <b>F2)</b> The completeness of the SCsML cannot be demonstrated ( <i>see also Issue Sheet B-1</i> ). <b>F3)</b> There is no procedures on dedicated walkdowns (for SSC screening and ageing management reviews). The previous walkdowns were implemented in an ad-hoc manner and their results were not documented. <b>F4)</b> Trending analysis of the reactor operating data, including those from functional and periodic testing, maintenance, inspection, surveillance, are not utilized systematically for development of ageing management programme and CSO or for their continuous improvement.	
<b>2.2 – SAFETY CONSEQUENCE:</b> Inconsistency between the documents on ageing management and CSO (PLAMP, AMPs) with the plant operating programmes or documentation, and lack of procedures for ensuring the completeness of SCsML, dedicated walkdowns, and trending analysis will impact the effectiveness of the implementation of the ageing management and can jeopardize safety of the facility.	
<b>2.3 – RECOMMENDATION/SUGGESTION:</b> <b>R)</b> To further enhance the effectiveness of ageing management activities, procedures should be established for: <ul style="list-style-type: none"> <li>• Adequately addressing the interaction (interface) and ensuring consistency of activities on ageing management and CSO with the other plant operating programmes and documentation such as maintenance, inspection, surveillance, modification, safety analysis, and safety analysis report.</li> <li>• Ensuring the completeness and regular update of the SCsML for ageing management and CSO. Sources of information that could be used for such update include use of the process and instrumentation diagrams, facility’s documentation, and results of dedicated walkdowns for SSC screening.</li> <li>• Planning and implementation of dedicated walkdowns for ageing management purposes.</li> <li>• Systematic collection, analyses, and trending of the reactor operating data, including those from functional and periodic testing, maintenance, inspection, and surveillance,</li> </ul>	

and utilizing the results for continuous improvement of the ageing management programmes.	
<b>2.4 – IAEA BASIS:</b>	
<ul style="list-style-type: none"> <li>– SSR-3: para. 7.126</li> <li>– SSG-10: para. 2.12, 4.15, 5.2, 5.14-5.22, 5.27 and Section 7</li> <li>– SSG-48: para. 2.6, 4.34, 4.36, 5.15, 5.19, 5.28, 5.56, 5.57, 6.7 and 7.4</li> <li>– SSG-24: para. 5.13 and 5.15</li> <li>– SSG-37: para. 8.37 and 9.2</li> <li>– GS-G-3.1: para. 2.31, 6.66, 6.69 and 6.72-6.73</li> <li>– NS-G-2.13: para. 3.9, 5.35</li> <li>– NS-G-4.2: para. 3.5 and 5.5</li> <li>– SRS-99: Safety factor 2, Safety factor 3, Safety factor 4, Safety factor 7 and Safety factor 11</li> </ul>	
<b>2.5 – DOCUMENTS REVIEWED:</b>	
<ul style="list-style-type: none"> <li>– K2 HFR Cyclusrapport, HFR Cyclusrapport - Cyclus 2021-09, 24/02/2022</li> <li>– 2.5258.10/20.187965, Verouderingsbeheersing HFR HB's, 25/11/2020</li> <li>– NRG-25245/20.117523, Plant Level Ageing Management HFR, 04/08/2020</li> <li>– PSR-2022-008, Checklist Pre-Startup Review (PSR), 11/04/2022</li> <li>– NO-IB-VE-OD-021206, Assessment of HFR's Manufacturing flaws TLAA, 22/04/2020</li> <li>– 25239/18.149056, HFR CSO TLAA scope, 16/07/2018</li> <li>– NRG-22.232927, Project 2022-008 Restore primary system pressure boundary and cooling of HB6, HB8 and HB 10, 03/02/2022</li> <li>– VORM- 2022-008, Veiligheid Ontwerp Rapport Modificatie (VORM), 06/03/2022</li> <li>– WV 2022-008, Wijzigingsvoorstel (WV), 17/02/2022</li> </ul>	
<b>3. COUNTERPART ACTIONS TO RESOLVE ISSUE</b>	<b>Date: 30/05/2024</b>
<b>3.1 – RESULTS OF THE ISSUE ANALYSIS:</b>	
<p>The PLAMP has been revised, in order to adequately manage the interfaces between HFR programs, projects and processes and the ageing management programme. For effective interface/interaction management, a frequency of occurrence and the associated responsible personnel have been assigned for each interaction. To facilitate with this, an interface management procedure and interaction template have been developed.</p> <p>A guideline for walkdowns has been developed to improve proactive identification of SSC ageing and to ensure completeness of the SCsML. Periodic walkdowns are now used as a tool for trending and proactive ageing identification which should lead to timely mitigative actions.</p> <p>Trendable parameters are being identified from different maintenance and operational procedures for predictive ageing management and trending. Identified trendable parameters and their respective acceptance criteria are being included in the relevant mechanical, electrical and civil maintenance procedures.</p>	
<b>3.2 – CORRECTIVE ACTIONS:</b>	
<ol style="list-style-type: none"> <li>1) The details of the interactions between HFR Plant Programs and the ageing management program, is to be adequately described in the PLAMP. A procedure is to be developed which would ensure effective interface management, this should include the</li> </ol>	

development of an interaction template to facilitate and document the exchanged of information.

- 2) Review and update maintenance procedures to improve the interfaces management, including the reference of relevant specific AMPs , SAR chapter, etc.
- 3) Develop a walkdown guideline and checklist to ensure effective and timely intervention on ageing related phenomena.
- 4) Identify trendable parameters of which their trending will improve maintenance procedures and lead to better ageing management and less corrective maintenance. Examples of sources from where data can be collected include functional and periodic tests, periodic maintenance, inspection and surveillance.

### **3.3 – STATUS OF CORRECTIVE ACTIONS IMPLEMENTATION:**

- 1) The PLAMP has been improved by thoroughly explaining the interaction between relevant parts of Ageing Management and other projects and programmes. The revised chapter includes advise on the frequency in which interactions should be evaluated and specifies the roles and responsibilities of required personnel to effectively review possible interactions between the relevant programmes/processes. See interface management procedure NO-IB-VE-PD-021464 and interaction template NO-IB-VE-OD-021463, which are available on the Management System.
- 2) Updated and approved maintenance procedures that include references to the specific AMPs are available in the Management System. For the mechanical maintenance procedures this has been finalized. For electrical, I&C and Civil this is still ongoing.
- 3) Walkdown guideline and checklist has been finalized and is available in the Management System (NO-IB-VE-OD-021358). An approach to systematically perform plant walkdowns is being developed.
- 4) Systematic identification, collection, analysis and trending of the reactor operating data is in early implementation phase. As part of the project to set-up acceptance criteria for I&C components (see NRG Note 2.5245.50/23.274524), trendable components will be identified for which relevant maintenance and/or operational procedures will be updated. Other examples, where trending of parameters related to civil structures is applied, are:
  - The building settlement report (NRG Note 2.5245.50.24.284916) is used to trend the settlement of the different building on the HFR site. PPO-BC-002 will be updated to include trending of the applicable parameters and to assess whether the recorded value still fall within the noted acceptance criteria.
  - The containment leak-rate test results are trended after each test and acceptance criteria has been correctly applied. The latest report is NO-O-HFR-OD-0269.
  - The leak-rates from the Aluminium pool-liner are recorded, analysed and reported on a bi-weekly basis.
  - A condition assessment of all the HFR structures has been performed and a baseline condition has been recorded. The revised civil maintenance procedure will include the trendable parameters and will define the responsibilities regarding trending and the associated procedures.

### **4. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM**

**Date: 03/07/2024**

#### **4.1 – FACTS:**

**F1)** PLAMP has been updated to provide more comprehensive guidance on interface management. Descriptions have been added for each of the interactions between relevant parts of ageing management and other programmes/processes. The updated PLAMP includes advise on the frequency in which interactions need to be evaluated and specifies the roles and responsibilities of involved personnel. The updated PLAMP also includes

references to all interfaces, such as SAR, drawings, and individual AMPs. New procedures were also developed to conduct interface management by recording the type of change, cause, effect, action, responsible personnel, and due date.

**F2)** A comprehensive walkdown procedure has been developed. The walkdown aims to support proactive ageing management, condition assessment, and continuous improvement of ageing management by adjusting the scope. Minimum of six walkdowns will be implemented per year, focusing on different subject areas in a way that the same subject area is not repeated within three years.

**F3)** Trending analysis has been performed since the main CSO mission. Examples include chemical analysis of leaking water from the pools, measurements of differential settlement between HFR buildings, and instrument calibration and drift tolerances. Results of trending analysis are being utilized for further development of ageing management programme, e.g. determining acceptance criteria.

**4.2 – DOCUMENTS REVIEWED:**

- NO-IB-VE-BD-020392, Plant Level Ageing Management Program HFR (rev. 2), 25/06/2024;
- NO-O-HFR-OD-0269, Containment Leak Rate;
- NO-IB-VE-OD-021463, Interface Document;
- NO-IB-VE-PD-021464, Interface Management Procedure;
- TITRSA-P5\_23.274524, Primary Cooling Water Outlet Temperature;
- 1.0\_24.284916, Building Settlement Report;
- NO-IB-VE-OD-021358, Walkdown Guideline and Checklist.

**4.3 – RESOLUTION DEGREE:**

<b>1.</b>	<b>Insufficient progress to date</b>	
<b>2.</b>	<b>Satisfactory progress to date</b>	
<b>3.</b>	<b>Issue resolved</b>	X

<b>1. ISSUE IDENTIFICATION</b>	<b>Issue Number: C-1</b>
<b>Research reactor: HFR</b>	
<b>Reviewed Area: Ageing management of mechanical SSCs</b>	
<b>1.1: ISSUE TITLE:</b> Shortcomings in the development and implementation of AMPs for some mechanical SSCs	
<b>1.2: FUNDAMENTAL OVERALL PROBLEM:</b> Some AMPs of mechanical SSCs do not systematically incorporate the attributes of ageing management and include incomplete or generic information, and some inconsistencies exist.	
<b>2. ASSESSMENT OF THE STATUS</b>	<b>Date: 24/06/2022</b>
<b>2.1 – FACTS:</b>	
<p><b>F1)</b> Most of AMPs for mechanical SSCs are in process of implementation.</p> <p><b>F2)</b> The ageing management attributes (elements) are not systematically considered. Instead, a table showing compliance with these attributes is provided in each AMP. (See also, for example, <i>Issue Sheet A-2</i>). Another example, AMP for tanks indicates that trending is not applicable in the compliance table but Annex 2 of it shows water chemistry programme for trending.</p> <p><b>F3)</b> Some information in the AMPs is generic (not specific to the SSC under consideration); e.g. AMP for piping whereas the scope excludes radiation damage, but discusses that mechanism (in the surveillance part) for the inlet and outlet sections of the primary cooling pipes. Another example is the process and environmental conditions which is included in Annex I of the AMP for tanks, which is not specific to that component.</p> <p><b>F4)</b> AMP for equipment qualification is described in a generic manner; for example generic tables for service conditions and environmental conditions are used instead of the harsh conditions for which SSCs are qualified.</p> <p><b>F5)</b> The IAEA team review of AMP 800 for piping showed that it contains proposals and actions but not developed as a systematic programme. Phrases such as ‘advised’, and ‘should be’ are included. Timeframe of implementation of the proposals on ageing management actions (e.g. refurbishment, modernization) is not defined.</p> <p><b>F6)</b> The identified degradation mechanisms do not include “thermal ageing” (e.g. effect of temperature) is not applicable to any of SSCs, which is not correct (e.g. applicable to rubber material).</p> <p><b>F7)</b> The IAEA team reviewed in detail several specific AMPs and had the following comments:</p> <ul style="list-style-type: none"> <li>- AMP 330 (air conditioning): The scope does not name the SSCs.</li> <li>- Water chemistry is used in several AMPs for monitoring the ageing effects, but it is also used for minimizing ageing effects.</li> <li>- Parameters that are used for monitoring ageing effects are not defined in several AMPs.</li> <li>- AMP 201 for valves: the specified acceptance criteria as “The [water chemistry programme] WCP specifies the acceptance criteria for the parameters that are controlled”, is not appropriate.</li> <li>- AMP 500 for tanks, mentions in the “compliance table” that preventive actions, monitoring, mitigation, and acceptance criteria are not applicable.</li> </ul>	

**2.2 – SAFETY CONSEQUENCE:**

Incomplete and insufficient description of the AMPs could result in the programme being not fully effective.

**2.3 – RECOMMENDATION/SUGGESTION:**

**R)** AMPs for mechanical SSCs should be reviewed and revised, as needed, to ensure that they are in accordance with the ageing management attributes (elements) established by the IAEA safety standards, including ensuring their specificity to the SSCs under consideration covering applicable degradation mechanisms, monitoring, acceptance criteria, and ageing management actions.

**2.4 – IAEA BASIS:**

- SSR-3: Requirement 37
- SSG-10: para. 2.1-2.3, 2.8 (b) (d), 3.3, 4.2, 4.4, 4.15 (h), 5.1, 5.2, 5.4, 5.9, 5.11-5.14, 5.19, 5.23, 5.26-5.33, 7.4-7.7

**2.5 – DOCUMENTS REVIEWED:**

- SCsML
- AMP 800 -Piping- PIP-CW-0-2, 2022
- AMP 501 -Tanks- TNK-CW-0-2, 2020
- AMP 4000 -Equipment Qualification, 2020
- AMP 330 -Air conditioning system- AIR-AG-1-1, 2022
- AMP 201 - Valves - VLV-CW-0-1, 2022
- AMP 205 -Valves- VLV-CW-1-2, 2022
- AMP 500 -Tanks- TNK-UW-0-1, 2022
- N Melding N5 2022 (In Dutch)

**3. HOSTING ORGANIZATION ACTIONS TO RESOLVE ISSUES****Date: 30/05/2024****3.1 – RESULTS OF THE ISSUE ANALYSIS:**

A comprehensive review of the Mechanical AMPs has been performed using a review checklist for a systematic approach. A consistent and thorough review was performed to the scope of the AMPs for incomplete and inconsistent information between the Asset Register and the Master List. Where needed actions have been included in the relevant AMPs. Consistency of the 9 attributes table is reviewed in accordance with SSG-10 and all the mechanical AMPs have been revised to include the reviewed 9 attributes table. Justification for exclusion of thermal ageing as possible ageing mechanisms at the HFR has been assessed, taking into account the environmental/process conditions of the SSCs made of plastics.

**3.2 – CORRECTIVE ACTIONS:**

- 1) Review all existing Mechanical AMPs and revise incomplete and inconsistent information, including an up-to-date status of the actions.
- 2) Define the Equipment Qualification Program as an HFR Plant Programs. Assess the EQP in accordance with the new SSG-69.
- 3) Perform an evaluation of thermal ageing as a relevant ageing mechanism for all types of plastic and including rubbers at the HFR. Report the outcome in Chapter 8.4 of the PLAMP.

**3.3 – STATUS OF CORRECTIVE ACTIONS IMPLEMENTATION:**

- 1) Review of the mechanical AMPs is ongoing, many of the AMPs have been revised and is currently in the review process.

<p>2) The policy document for the Equipment Qualification Program is available on the MS (NO-IB-VE-BD-020684). The assessment in accordance with SSG-69 resulted in no further action or changes to the program.</p> <p>3) Evaluation of thermal ageing as a relevant ageing mechanism has been performed in report K.6180.10/24.284857. The outcome of the evaluation justifies the non-inclusion of thermal ageing at the HFR. No further actions are needed. The outcome will be referenced in the new revision of the PLAMP.</p>		
<p><b>4. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM</b></p>		
<p><b>Date: 04/07/2024</b></p>		
<p><b>4.1 – FACTS:</b></p> <p><b>F1)</b> The HFR equipment qualification programme was revised in 2022 to update the scope of the programme and then in 2023 to further align with the applicable codes and standards, in particular the IAEA Safety Standards Series No. SSG-69, Equipment Qualification for Nuclear Installations.</p> <p><b>F2)</b> The latest version of the qualification programme includes a section on harsh conditions caused by postulated initiating events. The values of the key parameters were taken from the results of safety assessment and will be used as the qualification envelope for the key SSCs in the reactor safety system.</p> <p><b>F3)</b> An evaluation of thermal ageing was performed by HFR and documented in a report. It investigated the possible ageing mechanism for all types of polymeric materials, including rubbers used at HFR. The outcome of the report was summarized in Chapter 8.4 of the PLAMP to highlight thermal ageing as a non-reversible degradation mechanism.</p> <p><b>F4)</b> Many existing mechanical AMPs have been reviewed and revised, if incomplete or inconsistent information was found. For example, AMP 800 (Piping) was also revised to reflect the recent measurements. In addition, AMP 201 (Valves) was revised to update the acceptance criteria. AMP 500 (Tanks) was not revised to update the preventive actions and acceptance criteria, but the revision is planned.</p> <p><b>F5)</b> Additional efforts are needed to determine the appropriate acceptance criteria for many mechanical AMPs (also see Issue Sheet A-2).</p>		
<p><b>4.2 – DOCUMENTS REVIEWED:</b></p> <ul style="list-style-type: none"> <li>– NO-IB-VE-BD-020684, Equipment Qualification Program (rev.3), 20/10/2023;</li> <li>– K.6180.10/24.284857, Thermal Ageing as a possible ageing mechanism for polymeric materials in Systems, Structures and Components of the HFR (rev. A), 13/05/2024;</li> </ul>		
<p><b>4.3 – RESOLUTION DEGREE:</b></p>		
1.	Insufficient progress to date	
2.	Satisfactory progress to date	X
3.	Issue resolved	

<b>1. ISSUE IDENTIFICATION</b>	<b>Issue Number: C-2</b>
<b>Research reactor: HFR</b>	
<b>Reviewed Area: Ageing management of mechanical SSCs</b>	
<b>1.1: ISSUE TITLE:</b> Lack of maintenance programme of spare parts for SSCs important to safety and monitoring of their storage conditions	
<b>1.2: FUNDAMENTAL OVERALL PROBLEM:</b> There is no maintenance programme of spare parts for SSCs important to safety established, and storage conditions of the spare parts are not controlled nor monitored.	
<b>2. ASSESSMENT OF THE STATUS</b>	<b>Date: 24/06/2022</b>
<b>2.1 – FACTS:</b> <b>F1)</b> An AMP for spare parts has been developed, but deficiencies exist. <b>F2)</b> There is no maintenance programme of spare parts for SSCs important to safety. <b>F3)</b> There is a database of spare parts for mechanical SSCs; whereas there is no database of spare parts for electrical and I&C SSCs. <b>F4)</b> Some spare parts have a shelf life and storage condition prescribed, but this information is not added to any database. The entry date of a spare part in storage is unknown and therefore it is not possible to determine how long this specific spare part has been in storage and how long it may stay in storage. <b>F5)</b> The storage conditions of the spare parts are not controlled nor monitored.	
<b>2.2 – SAFETY CONSEQUENCE:</b> Without maintenance and monitoring of spare parts for SSCs important to safety, unanticipated early failure of the spare parts can occur. Without an appropriate inventory control system (or a database) of spare parts including the numbers required, their condition, shelf life, and control of storage conditions, the deterioration in storage and non-availability of spare parts could occur.	
<b>2.3 – RECOMMENDATION/SUGGESTION:</b> <b>R)</b> A maintenance programme of spare parts for SSCs important to safety should be established, including control and monitoring of the storage conditions.	
<b>2.4 – IAEA BASIS:</b> <ul style="list-style-type: none"> <li>– SSR-3: Requirement 67</li> <li>– SSG-10: para. 2.8 (d), 4.15 (h)</li> <li>– NS-G-4.2: para. 5.24</li> </ul>	
<b>2.5 – DOCUMENTS REVIEWED:</b> <ul style="list-style-type: none"> <li>– Plant Level Ageing Management HFR, 2020</li> <li>– AMP 1000 -Spare parts- SPR-AG-1-2, 2020</li> </ul>	
<b>3. HOSTING ORGANIZATION ACTIONS TO RESOLVE ISSUES</b>	<b>Date: 30/05/2024</b>
<b>3.1 – RESULTS OF THE ISSUE ANALYSIS:</b> A maintenance programme for spare parts of SSCs important to safety is currently in development. Furthermore, a database has been developed, to better manage electrical and I&C spares. Due to resource constraints, a central, climate controlled storage building has not yet been established. However, the required storage conditions for mechanical and	

electronic (electrical and I&C) spare parts are being assessed, which will provide input to the spare parts maintenance programme, also currently in development.

**3.2 – CORRECTIVE ACTIONS:**

- 1) Develop a maintenance programme for spare parts of SSCs important to safety.
- 2) Develop a database for Electrical and I&C spare parts, including fields for shelf-life and storage starting date.
- 3) Develop maintenance procedures for all spare parts.
- 4) Investigate and define the required storage conditions of spare parts for both mechanical and electrical components.
- 5) Build/allocate a centralized, climate controlled storage facility for mechanical, electrical and I&C components to improve physical and administrative management of spare parts.

**3.3 – STATUS OF CORRECTIVE ACTIONS IMPLEMENTATION:**

- 1) The maintenance programme for spare parts is in development. The policy document is currently in a draft stage.
- 2) A database has been established for the electrical and I&C. This database includes an identifier, function, fabricator, model number, importance to operations, shelf-life and whether the product is still produced. Personnel have been trained to use the database.
- 3) Maintenance procedures are in development, one example of such is PPO-A009 (NO-M-HFR-OD-021582). Visual inspections of spare parts to detect possible ageing mechanisms is included in this PPO.
- 4) Assessment of the required storage conditions for the mechanical spare parts is currently in progress and will be captured in the maintenance program for spare parts. The required storage conditions for the electronic spare parts are being investigated and reported in the first revision of NRG note 2.5245.50/24.285014. This will also be used as input for the maintenance programme for spare parts.
- 5) NRG is evaluating the possibility of converting an unused building on site into a storage facility; which will house spare parts for all the nuclear facilities on the Petten site.

<b>4. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM</b>	<b>Date: 04/07/2024</b>
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**4.1 – FACTS:**

**F1)** A spare parts database for all electrical and I&C SSCs has been developed since 2023 and is maintained the HFR maintenance department. The IAEA team found the database is comprehensive and has user friendly features. The IAEA team also verified the consistency of information between the spare parts database and the resulted obtained from the obsolescence screening (see Issue Sheet A-1).

**F2)** A full audit of the spare parts storage against the spare parts database is performed annually. The storage condition of electrical and I&C SSCs are assessed during the audit.

**F3)** The information of shelf time is added for newly stored spare parts.

**F4)** Maintenance procedures are under development for spare parts and are to be integrated into a maintenance programme for spare parts.

**F5)** The operating organization is evaluating the possibility of converting an unused building on site into a storage facility, which will house spare parts for all the nuclear facilities on the Petten site.

**4.2 – DOCUMENTS REVIEWED:**

- Voorbeeld Access database, EIS Spare Parts Management System;

- PPO-A009 NO-M-HFR-OD-021582, Maintenance procedures for visual inspections of spare parts;
- 2.5245.50/24.285014, Storage Conditions of Electrical and I&C Spares at the HFR, 30 May 2024.

**4.3 – RESOLUTION DEGREE:**

<b>1.</b>	<b>Insufficient progress to date</b>	
<b>2.</b>	<b>Satisfactory progress to date</b>	
<b>3.</b>	<b>Issue resolved</b>	X

<b>1. ISSUE IDENTIFICATION</b>	<b>Issue Number: D-1</b>
<b>Research reactor: HFR</b>	
<b>Reviewed Area: Ageing management of electrical and I&amp;C SSCs</b>	
<b>1.2 – ISSUE TITLE:</b> Deficiencies in some AMPs for electrical and I&C SSCs	
<b>1.2 – FUNDAMENTAL OVERALL PROBLEM:</b> There is a need to complete the development of AMPs for several electrical and I&C SSCs, and to ensure inclusion of ageing effects, monitoring and management actions in all relevant programmes.	
<b>2. ASSESSMENT OF THE STATUS</b>	<b>Date: 24/06/2022</b>
<b>2.1 – FACTS:</b> <b>F1)</b> Work was initiated for identification of alternative suppliers for old or obsolete I&C equipment. In the past recent years, two safety channels were modernized from use of analogue to digital technology, and modernization of another two is ongoing. (See <i>Issue Sheet A-1</i> on obsolescence management). <b>F2)</b> Monitoring of conditions does not cover all electrical and I&C systems and components. <b>F3)</b> Trending of failure rates of electrical and I&C systems and components is not systematically performed (see also <i>Issue Sheet B-2</i> ). Additionally, further investigation is needed on testing of response time of the temperature, flow, pressure, level sensors (as per the draft document NRG 2.5235.31/21-212992). <b>F4)</b> There is no maintenance programme, or database, for spare parts of electrical and I&C components (see <i>Issue Sheet C-2</i> ). <b>F5)</b> The analysis and identification of ageing effects for electrical and I&C systems and components important to safety is incomplete, e.g. I&C for the primary core cooling and pool cooling systems. <b>F6)</b> Some AMPs are not yet developed (for examples items 2530 – 2580). <b>F7)</b> During the walkdown of the facility, it was observed that: <ul style="list-style-type: none"> <li>– Type and conditions of electrical and I&amp;C cables insulation in various areas are unknown.</li> <li>– Incomplete identification of the electrical and I&amp;C cables.</li> <li>– Lack of identification of electrical and I&amp;C equipment, including I&amp;C safety trains.</li> <li>– Physical separation between some redundant components is not ensured.</li> </ul>	
<b>2.2 – SAFETY CONSEQUENCE:</b> Without adequate aging management of electrical and I&C systems and components the safety function of electrical and I&C systems and components important to safety cannot be ensured.	
<b>2.3 – RECOMMENDATION/SUGGESTION:</b> <b>R)</b> Development of AMPs should be finalized for all in scope electrical and I&C components, ensuring identification of relevant ageing effects, monitoring, and aging management actions. For effective implementation of AMPs, a process should be initiated for identification of cables, and accordingly, install proper labelling. <b>S)</b> Physical separation between redundant safety channels should be considered in future modernization of the I&C system.	

<b>2.4 – IAEA BASIS:</b>	
<ul style="list-style-type: none"> <li>– SSG-10: para. 5.11, 5.19-5.21, 6.3</li> <li>– SSG-37: para. 4.37</li> </ul>	
<b>2.5 – DOCUMENTS REVIEWED:</b>	
<ul style="list-style-type: none"> <li>– AMP 3000 Obsolescence Program</li> <li>– AMP 4000 Equipment Qualification</li> <li>– AMP-1100-Diesel Generators-DIE-FS-0-1 as an example</li> <li>– Index of M.S. Maintenance Documents (Preventive Maintenance)</li> <li>– Preventative Maintenance Program</li> <li>– Draft NRG 2.5235.31/21-212992 Program to address SSC sensor response time testing for acceptance and trend analysis</li> <li>– HFR SCsML.</li> </ul>	
<b>3. COUNTERPART ACTIONS TO RESOLVE ISSUE</b>	<b>Date: 30/05/2024</b>
<b>3.1 – RESULTS OF THE ISSUE ANALYSIS:</b>	
<p>The development of AMPs for electrical and I&amp;C components have significantly progressed in the past 24 months. Many of the corrective actions related to other Issue Sheets also cover recommendations made in this Issue Sheet. For example, non-physical ageing (obsolescence) is managed within the obsolescence program (Issue Sheet A1), acceptance criteria for the electrical PPOs are being developed, as well as the identification of trendable parameters (Issue Sheet A2); scope screening is guaranteed by walkdowns and gap analyses (Issue Sheet B1). To improve spare parts management, a database has been established for electrical components (Issue Sheet C2). Within the scope of electrical AMPs, the functionality of the cable lists has been improved by converting the data into an Excel-file. A feasibility study of physically separating redundant nuclear safety channels was performed and identified improvements; some of which have been adopted by the facility.</p>	
<b>3.2 – CORRECTIVE ACTIONS:</b>	
<ol style="list-style-type: none"> <li>1) Further develop AMPs of electrical and I&amp;C components.</li> <li>2) Assess the feasibility of trending the failure rates for electrical and I&amp;C SSCs.</li> <li>3) Review and revise the existing electrical AMPs to ensure consistency with SSG-10.</li> <li>4) Perform a feasibility study on the physical separation of redundant nuclear safety channels.</li> </ol>	
<b>3.3 – STATUS OF CORRECTIVE ACTIONS IMPLEMENTATION:</b>	
<ol style="list-style-type: none"> <li>1) The development of the AMPs is ongoing and will include the revised safety classification of the electrical and I&amp;C SSCs.</li> <li>2) A methodology to trend failure rates of electrical and I&amp;C components is currently in development, see draft report 24.283486. In the meantime, trending is performed during the monthly FRACAS meetings (procedure (NO-M-HFR-PD-021975), which is attended by engineers and maintenance personnel.</li> <li>3) The existing AMPs are being reviewed and revised for inconsistencies. The AMPs will be revised to include the corrective actions described in issue sheet A2, B1 and C2.</li> <li>4) A feasibility study of physically separating redundant nuclear safety channels has been performed and has been captured in report 23.268520. Findings from the feasibility has initiated a modification to the plant, which is currently being engineered.</li> </ol>	
<b>4. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM</b>	<b>Date: 04/07/2024</b>
<b>4.1 – FACTS:</b>	

**F1)** As I&C failures are not common, and as they are all searchable for repeated failure in SAP, HFR concluded that the most effective and efficient way to track repeat failures of I&C SSCs is to highlight them at the daily meeting and interrogate SAP as required. Repeated failures of I&C SSCs will be further discussed at the FRACAS meeting, when applicable;

**F2)** A spare parts database for all I&C and electrical equipment has been developed (see also in Issue Sheet C-2);

**F3)** I&C SSCs used in the reactor safety system (and in the reactivity control system) have been analysed in the SAR and their associated AMP were updated. The remaining I&C SSCs are planned to be included in the SAR revision, which needs additional efforts.

**F4)** All in-scope I&C SSCs are covered in the individual AMPs 2520 – 2580. They are, however, not yet finalized, pending the planned SAR revision.

**F5)** Cabling in the reactor facility has been labelled. Cable identification register was found and have been collated into a Excel spreadsheet, which is owned by the HFR Engineering teams' drawing office. A procedure for encoding and labelling of piping is available in the Management System and provides instruction on how to assign a unique and recognizable code to the pipelines. The implementation of this procedure is currently on-hold due to resource constraints, but will be considered in the future. The HFR Pipeline list (Excel-template NO-IB-VE-OD-022306) has been developed to register the labelled pipe.

**F6)** A comprehensive feasibility study for the separation of redundant nuclear safety channels was performed. Seven options were considered in the feasibility study. The decision was made to progress two options for the management of potential water ingress into the nucleonic channels, for the separation of their associated metal distribution boxes to prevent a common cause event, and also for the improvement in water sealing.

**4.2 – DOCUMENTS REVIEWED:**

- I&C Spare Parts Database;
- Feasibility study on physical separation of HFR nuclear channels as a part of CSO-mission 2022 suggestions;
- NO-M-HFR-PD-021975, FRACAS procedure;
- NO-IB-VE-OD-022306, HFR Pipeline List.

**4.3 – RESOLUTION DEGREE:**

<b>1.</b>	<b>Insufficient progress to date</b>	
<b>2.</b>	<b>Satisfactory progress to date</b>	X
<b>3.</b>	<b>Issue resolved</b>	

<b>1. ISSUE IDENTIFICATION</b>	<b>Issue Number: E-1</b>
<b>Research reactor: HFR</b>	
<b>Reviewed Area: Ageing management of civil SSCs</b>	
<b>1.1 – ISSUE TITLE:</b> Shortcomings in ageing management review of civil structures and components	
<b>1.2 – FUNDAMENTAL OVERALL PROBLEM:</b> Ageing management review is not performed in a comprehensive manner for ageing management of civil structures and components.	
<b>2. ASSESSMENT OF THE STATUS</b>	<b>Date: 24/06/2022</b>
<b>2.1 – FACTS:</b>	
<p><b>F1)</b> AMRs of civil structures have been performed in 2014 using the methodology developed in 2013 (<i>NRG-2.3277.10/13.120286</i>), which is based on IAEA documents that have since been superseded. This methodology document does not contain requirements on systematic identification of ageing effects, identification of current condition of structures, and qualification requirements for personnel performing AMRs of civil structures.</p> <p><b>F2)</b> The results of AMRs performed in 2014 contain information on degradation mechanisms, but they do not identify their effects. AMRs have not been performed by civil engineers. Comprehensive condition assessments have not been performed as part of AMR and current condition of structures is not identified in AMRs (or AMPs). This is also valid for the AMRs that were reviewed/updated in 2019.</p> <p><b>F3)</b> Some inspections/walkdowns to identify current condition of structures have been performed. However, there is no methodology for the walkdowns/inspections, and results have not been documented (see <i>Issue Sheet B-2</i>).</p> <p><b>F4)</b> Degradation mechanisms are not specifically identified for all structures and their components. For example, <i>AMP 904</i> (Foundation) identifies that foundation may experience chemical attack including Delayed Ettringite Formation and Alkali Aggregate Reaction. It is, however, silent on other types of chemical attack (e.g. sulphate attack, acid attack, and leaching). Another example is <i>AMP 920</i> (Wells), where chemical attack is identified as a degradation mechanism; however, it does not say which type of attack is of concern.</p> <p><b>F5)</b> Design drawings are available; however limited design documents are available. Comparison of design parameters to operating parameters is not documented in AMRs or AMPs.</p> <p><b>F6)</b> Functions of the structures and components are not defined in AMRs and AMPs. The maintenance programme and the SAR are referenced for identification of the functions. However, the maintenance programme does not define functions of the structures; while the SAR defines the functions of the buildings but not their components (e.g. function of containment isolation is not identified). It is also difficult to define functions of commodities in the SAR.</p> <p><b>F7)</b> Trends for some of the parameters have not been identified in AMRs or AMPs. For example, settlement of the buildings has been measured since 2007; however it has not been trended. Similarly, containment leakage rate tests are being performed annually. However, trending of results is not available in AMRs or AMPs.</p> <p><b>F8)</b> Specific projects have been initiated to identify and address ageing of the three structures including stack degradation, pools' leakage and containment corrosion. Current condition of these structures has been identified and in case of the stack repairs have been performed. Chemical analysis of leaking water and its comparison with the parameters of the water in</p>	

the pools are not being performed (except for checking it for tritium to rule out leakage from the vessel), although it can provide valuable information for ageing management of pools' structure.

## **2.2 – SAFETY CONSEQUENCE:**

Without comprehensive AMRs, it cannot be ensured that all degradation mechanisms and their effects will be adequately managed.

## **2.3 – RECOMMENDATION/SUGGESTION:**

**R)** The AMR methodology should be updated in accordance with the IAEA safety standards. The AMRs should be performed for all in-scope civil structures and components to ensure that all relevant elements are effectively addressed, including identification of design basis, current condition, and degradation mechanisms and their effects.

**S)** It is suggested to perform periodical chemical analysis of leaking water from the pools and utilize the results to improve the ageing management of pools' structure.

## **2.4 – IAEA BASIS:**

- SSR-3: Requirements 2, 70, 86
- SSG-10: para. 2.8 (f), 5.9, 5.19

## **2.5 – DOCUMENTS REVIEWED:**

- NRF-2.3277.10/13.120286, AMR Methodology (2013);
- NRG-2.3448/13.123034, Ageing Management Review (Buildings) (2014);
- NRG-2.3448/13.120994, Ageing Management Review (Pools) (2014);
- NRG-78445/17.144571.NO, Technical Document on Properties of Concrete of the Pools. (2017);
- NRG-23444/17.143704, Seismic Evaluation of OLP (2018);
- BV-AM52.10, Leakage in Reactor Hall. Operating Procedure;
- BV-H09 Periodic Leak Rate testing for Containment;
- 2523923/18.148970, Maintenance Programme HFR (2018);
- 25239/18.149056, HFR CSO TLAA scope (2018);
- NO-IB-HFR-PD0012, Failure Report Analysis and Corrective Action Procedure (2020);
- AMP 901, NO-IB-VE-OD-020660, Containment Steel (2022);
- AMP 902, NO-IB-VE-OD-020661, Metallic Supports (2022);
- AMP 903, NO-IB-VE-OD-020662, Active Parts Locks (2022);
- AMP 904, NO-IB-VE-OD-020663, Foundation (2022);
- PRO-BC-002, Settlement Measurements;
- AMP 905, NO-IB-VE-OD-020664, Masonry Walls (2022);
- PPO-M-065E, Inspection of Well (2017);
- PPO-M-065A, Inspection of Well (2017);
- AMP 906, NO-IB-VE-OD-020665, Structural Elements (2022);
- AMP 907, NO-IB-VE-OD-020666, Doors Sealing (2022);
- AMP 908, NO-IB-VE-OD-020667, Hall Spray and Ventilation (2022);
- AMP 910, NO-IB-VE-OD-020668, Pools (2022);
- PRO-M-066, Concrete Structure Pipe Corridor Inspection
- PRO-M-066A, Inspection of Concrete Structure in Sub-pile Room

- AMP 920, NO-IB-VE-OD-020669, Wells (2022);
- AMP 930, NO-IB-VE-OD-020670, Fire and Lightning Protection (2022);
- AMP 950, NO-IB-VE-OD-020696, Penetration Plates (2022).

### **3. COUNTERPART ACTIONS TO RESOLVE ISSUE**

**Date: 30/05/2024**

#### **3.1 – RESULTS OF THE ISSUE ANALYSIS:**

Progress has been made to improve the Ageing Management Review (AMR) process. As part of this improvement, a procedure to systematically perform the AMR, including clear instruction and guidelines for effective execution, has been established.

The HFR buildings have been assessed to determine the condition of the structures and to establish a baseline. The relevant outcomes of the condition assessment will be documented in a note/report on the condition evaluation for HFR buildings. Ageing effects and degradation mechanism are identified and captured in this evaluation report. It is intended that this leads to the establishment of an appropriate ageing management programme which will address the identified issues.

A walkdown guideline and checklist has been introduced, aiming to identify possible relevant ageing mechanisms and to assess the existing management strategies. Parameters are identified for which trending may give insight on the current condition of buildings. Acceptance criteria are established for the monitoring and trending of such parameters.

Chemical analysis of the pool water and pool liner leakage water (through concrete) has been performed on an ad-hoc basis since 2022 but with sub-optimal theoretical basis and/or insightful trending. It is expected/proposed that insights into the concrete condition (at least along the leak paths) could be obtained through comparative evaluation of the pool water and pool liner leakage water chemical analysis results. For this purpose, parameters relevant for detecting potential concrete degradation mechanisms (e.g. ASR) in the pool concrete will be identified and captured in the Water Chemistry Program (currently in the process of being updated). Furthermore, procedures have been established to perform routine sampling and chemical analysis of concrete leak water. Efforts have been initiated to trend this data in order to obtain potentially useful information related to concrete degradation.

#### **3.2 – CORRECTIVE ACTIONS:**

- 1) Perform a condition assessment of the HFR structures by qualified contractors and Civil Engineers. This should be done in accordance with NEN276, which is the standard used in the Kingdom of the Netherlands.
- 2) Write a guideline for performing walkdowns which takes into account the assessment of the scope of civil structures and possible degradation mechanisms at play.
- 3) Update the PLAMP to include instruction on how to perform an AMR at the HFR.
- 4) Establish procedures for performing ageing management reviews, in accordance with the PLAMP.
- 5) Identify trendable parameters for ageing management purposes of civil structures. Define associated acceptance criteria for the new and existing parameters.
- 6) Develop a procedure for routine sampling and chemical analysis of the concrete leak water.

#### **3.3 – STATUS OF CORRECTIVE ACTIONS IMPLEMENTATION:**

- 1) As part of the AMR for civil structures, the condition assessment of the HFR buildings was performed in the Q4 of 2023. Relevant findings have been captured in this condition assessment of safety related buildings (reference: 2.5245.50.270996). The findings of this assessment will be used to update relevant civil AMPs to include all potential ageing mechanisms.

- 2) A walkdown guideline is available on the MS (NO-IB-VE-OD-021358). Efforts are ongoing to systematically coordinate the walkdowns and consolidate findings from the walkdowns.
- 3) The revised PLAMP includes a detailed description on how to perform an AMR, in accordance with SSG-48.
- 4) A procedure for performing an AMR has been developed and is available on the management system (NO-IB-VE-PD-021490).
- 5) Trendable parameters have been identified within ageing management for the civil structures, for example the yearly building settlement evaluation, chemical parameters analysed from the pool (concrete) leak-water and crack growth measurement. For the trending of historical data, acceptance criteria were defined. Trending of building settlement data is performed and acceptance criteria are defined in the NRG note: 2.5245.50\_24.284916. Implementation of the trending of the available data for the HFR structures and the creation of a centralized data collection is envisioned.
- 6) The procedure for sampling and chemical analysis of pool leak-water has been developed and is available on the Management System, see maintenance procedure PPO-M-122 (NO-M-HFR-OD-021712). Parameters to analyse and trend are described in the procedure. The methodology for civil related chemical analysis of pool (concrete) leak-water will be described in the updated version of the Water Chemistry Program. AMPs of the pool structures will also be revised to include the monitoring of the pool (concrete) leak water chemical parameters. The Water Chemistry Program will be updated to reference the new procedure. A centralized data collection is envisaged in the future.

**4. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM**

**Date: 04/07/2024**

**4.1 – FACTS:**

**F1)** Condition assessment of HFR building and structures was performed as documented in the report (2.5245.50/24.270996, An Evaluation of the Condition of Safety Related Buildings). The current condition of the structures is assessed in the report. The identification of degradation mechanisms, however, was performed on a high level, where generic ageing effects for each construction material (e.g. concrete or steel) are discussed. Their applicability to the HFR structures is limited to an overall high-level justification statement.

**F2)** There is a new AMR procedure (NO-IB-VE-PD-021490), which addresses the AMR process on a high level. The document describes administrative responsibilities and contains the steps in the AMR process in accordance with the IAEA safety standards. However, the procedure does not elaborate the process that is to be implemented for specific structures, components, or commodity groups. For example, it is stated that most HFR structures are protected by masonry façades and sulphate attack is not an issue; however, there is no discussion regarding the underground portions of the buildings or concrete pile foundations of the reactor building exposed to the groundwater and soil, which, depending on the amounts of sulphates in those could be subjected to sulphate attack. There is no discussion on the amount of sulphates in the soil and groundwater to determine if the sulphate attack should be considered as a possible degradation mechanism. It is of the IAEA team’s opinion that considerable efforts remain needed to perform specific AMRs for in-scope structures and components with a systematic identification of the degradation mechanisms.

**F3)** Evaluation of parameters requiring trending is underway. Some of the identified parameters are being trended. For example, the measurements of the foundation settlements collected since 2007 are now being trended as documented in 2.5245.50/24.284916.

**F4)** Periodical chemical analysis of leaking water from the pools has been performed since the main CSO mission. The results are presented to the IAEA team and are utilized to improve the ageing management of pools' structure.

**4.2 – DOCUMENTS REVIEWED:**

- NO-IB-VE-PD-021490 Ageing Management Review Procedure (2022);
- 2.5245.50/24.270996 HFR Buildings Evaluation of the Condition of Safety Related Buildings. (2024);
- 2.5245.50/24.284916 Building Settlement – Trending and Acceptance Criteria. (2024);
- NO-IB-VE-OD-021358 Walkdown for Ageing Management - Guidelines and checklist (2022);
- NO-M-HFR-OD-021712 PPO-M-122 Monstername lekvaatjes in de recatorhal.

**4.3 – RESOLUTION DEGREE:**

<b>1.</b>	<b>Insufficient progress to date</b>	
<b>2.</b>	<b>Satisfactory progress to date</b>	X
<b>3.</b>	<b>Issue resolved</b>	

A new suggestion is provided for further guidance to ensure resolution of Issue E-1 within a reasonable timeframe:

**S)** HFR should consider performing specific AMRs for in-scope structures and components that may be organized in commodity groups based on similarities in their functions, materials, and environment. It is also suggested to prioritize structures and components subjected to the degradation mechanisms that can potentially result in the degradations having a greater safety consequence, e.g., foundations and pools;

<b>1. ISSUE IDENTIFICATION</b>	<b>Issue Number: E-2</b>
<b>Research reactor: HFR</b>	
<b>Reviewed Area: Ageing management of civil SSCs</b>	
<b>1.1 – ISSUE TITLE:</b> Shortcomings in the development of AMPs for civil structures	
<b>1.2 – FUNDAMENTAL OVERALL PROBLEM:</b> AMPs of civil SSCs do not systematically incorporate the attributes (elements) of effective ageing management programme	
<b>2. ASSESSMENT OF THE STATUS</b>	<b>Date: 24/06/2022</b>
<b>2.1 – FACTS:</b>	
<p><b>F1)</b> AMPs have recently been developed to address ageing of civil structures and commodities. AMPs are organized by commodities that are identified and justified typically as being of the same material and exposed to the same conditions. However, there are omissions in the scope. For example, <i>AMP 906</i> (Structural Elements) does not address structural elements of Building 113.</p> <p><b>F2)</b> The scopes of AMPs are clearly defined in most cases; however, there are some uncertainties with the boundaries and the interfaces with the other AMPs. For example in <i>AMP 902</i> (Metallic Supports), it is not clearly defined if the AMP covers only anchorage portion of the supports and where is the boundary of this AMP and the AMP for piping.</p> <p><b>F3)</b> Some civil AMPs do not address civil components. For example, <i>AMP 903</i> (Active Parts Locks) addresses moving parts of airlocks, which belong to mechanical SSCs.</p> <p><b>F4)</b> Some components of the structure such as membranes, coatings, and paints are not addressed in the scope of civil structures' AMPs. For example, these are not specifically addressed in <i>AMP 920</i> (Wells).</p> <p><b>F5)</b> The titles of the AMPs do not always accurately address the contents. For example, <i>AMP 907</i> (doors sealing) has watertight floors included in the scope in addition to the doors.</p> <p><b>F6)</b> Materials, service conditions, and the relevant degradation mechanisms are identified in AMPs. However, some errors have been noted. For example, <i>AMP 908</i> (Hall spray and Ventilation system), steel and concrete are identified as material, while there are no concrete components. On the other hand, plastics are not identified as a material, but inspection of plastic components is included.</p> <p><b>F7)</b> AMPs refer to the procedures for activities to minimize, detect, and mitigate ageing effects. Many of these procedures have not yet been developed, although activities may have been ongoing as part of other programmes.</p> <p><b>F8)</b> AMPs and procedures are missing some of the attributes (elements) of effective AMPs. Condition indicators, acceptance criteria and associated actions are missing from most AMPs. For example, in <i>AMP 910</i> (Pools), the leakage rate is not identified as condition indicator and there are no acceptance criteria and no corrective action identified in AMP. There is, however, operating procedure, according to which alarm is being triggered when leakage reaches certain values. Procedures for inspection of pool concrete (pipe corridor), <i>PPO-M-066</i> and <i>PPO-M-066A</i> do not identify condition indicators. Acceptance criteria that can be applied for visual inspection are not identified. Another example is <i>AMP 904</i> (Foundation), procedure <i>PRO-BC-002</i> for settlement measurements, which does not contain acceptance criteria.</p> <p><b>F9)</b> AMPs and procedures for detecting ageing do not contain several elements required for effective detection of ageing. For example, <i>PRO-BC-002</i> (Monitoring of Settlement) does</p>	

not identify locations for measurements, instrumentation used, condition indicators, acceptance criteria, ageing management actions, and documentation requirements.

**F10)** While some activities to detect ageing effects are identified in AMPs (e.g. visual inspections) other activities that are typically used to detect possibility of ageing effects particularly of inaccessible structures are not identified. For example, foundations in *AMP 904* are identified to be exposed to the action of the ground water (O7). However, periodic analysis of the ground water is not identified as one of the activities to detect the water table fluctuations or change in the stressors.

**F11)** There is a methodology document for identification of TLAAs (25239/18.149056). No TLAAs for civil structures have been identified. IGALL TLAAs have been considered not applicable to HFR civil structures However, justification has not been provided.

## **2.2 – SAFETY CONSEQUENCE:**

Without comprehensive development of AMPs for all in-scope civil structures, effective ageing management cannot be ensured.

## **2.3 – RECOMMENDATION/SUGGESTION:**

**R)** AMPs for civil structures and components should be reviewed and revised, as needed, to ensure that they are in accordance with the ageing management attributes (elements) established by the IAEA safety standards, including identification of condition indicators, acceptance criteria, and ageing management actions.

## **2.4 – IAEA BASIS:**

- SSR-3: Requirement 86
- SSG-10: para. 5.1, 5.2, 5.14, 5.20, 5.25

## **2.5 – DOCUMENTS REVIEWED:**

- NRF-2.3277.10/13.120286, AMR Methodology (2013);
- NRG-2.3448/13.123034, Ageing Management Review (Buildings) (2014);
- NRG-2.3448/13.120994, Ageing Management Review (Pools) (2014);
- NRG-78445/17.144571.NO, Technical Document on Properties of Concrete of the Pools. (2017);
- NRG-23444/17.143704, Seismic Evaluation of OLP (2018);
- BV-AM52.10, Leakage in Reactor Hall. Operating Procedure;
- BV-H09 Periodic Leak Rate testing for Containment;
- 2523923/18.148970, Maintenance Programme HFR (2018);
- 25239/18.149056, HFR CSO TLAA scope (2018);
- NO-IB-HFR-PD0012, Failure Report Analysis and Corrective Action Procedure (2020);
- AMP 901, NO-IB-VE-OD-020660, Containment Steel (2022);
- AMP 902, NO-IB-VE-OD-020661, Metallic Supports (2022);
- AMP 903, NO-IB-VE-OD-020662, Active Parts Locks (2022);
- AMP 904, NO-IB-VE-OD-020663, Foundation (2022);
- PRO-BC-002, Settlement Measurements;
- AMP 905, NO-IB-VE-OD-020664, Masonry Walls (2022);
- PPO-M-065E, Inspection of Well (2017);
- PPO-M-065A, Inspection of Well (2017);
- AMP 906, NO-IB-VE-OD-020665, Structural Elements (2022);

- AMP 907, NO-IB-VE-OD-020666, Doors Sealing (2022);
- AMP 908, NO-IB-VE-OD-020667, Hall Spray and Ventilation (2022);
- AMP 910, NO-IB-VE-OD-020668, Pools (2022);
- PRO-M-066, Concrete Structure Pipe Corridor Inspection
- PRO-M-066A, Inspection of Concrete Structure in Sub-pile Room
- AMP 920, NO-IB-VE-OD-020669, Wells (2022);
- AMP 930, NO-IB-VE-OD-020670, Fire and Lightning Protection (2022);
- AMP 950, NO-IB-VE-OD-020696, Penetration Plates (2022).

### **3. COUNTERPART ACTIONS TO RESOLVE ISSUE**

**Date: 30/05/2024**

#### **3.1 – RESULTS OF THE ISSUE ANALYSIS:**

Corrective actions currently being undertaken to address the shortcomings in the civil AMPs are also described in Issue Sheet E1. Comprehensive reviews of the civil AMPs are being performed to ensure that the scope and boundaries are well defined and inaccuracies/inconsistencies are resolved. Data collected as part of the ageing management programme is currently being used to trend the overall condition of the civil structures. Examples include measurements made during the building settlement analysis and chemical analysis of pool (concrete) leak-water. The trended data will be analysed in order to improve maintenance activities and/or proactively identify mitigation actions. Additionally, main degradation mechanisms, such as crack propagation of the concrete elements, are monitored in order to evaluate the effectiveness of the AMPs

The scope of the HFR TLAA was reviewed and excluded TLAA's have been justified. A selection procedure needed to be defined for the scope of the HFR's TLAA's. The scope of TLAA's needed to be revised, including possible TLAA's relevant for civil components. Implementation of the new TLAA's will be performed based on the outcome of the revised in-scope TLAA's. Ageing management programs need to be developed/identified within the HFR-AMP, for all TLAA's found to be applicable and not feasible at the HFR.

#### **3.2 – CORRECTIVE ACTIONS:**

- 1) Perform a comprehensive review of the civil AMPs with focus on the applied scope/boundaries, accuracy and completeness of the content as well as the applied ageing management strategies. Assess the status of actions and update the action list in the specific AMP.
- 2) Assess, against the relevant construction code, whether fatigue should be considered as a relevant ageing mechanism due to the yearly leak-rate test performed on the containment building. The basis for performing this study is to evaluate whether a reduction in the frequency of the test should be considered.
- 3) Perform a comprehensive review of the TLAA scope and include a procedure for TLAA-scope screening.
- 4) Implement new identified TLAA's or develop an AMP if the TLAA is found to be not feasible.

#### **3.3 – STATUS OF CORRECTIVE ACTIONS IMPLEMENTATION:**

- 1) Review and revision of the civil AMPs is ongoing and will include the findings from the AMR. Findings from the condition assessment reports of the civil structures will provide input for a new group of maintenance procedures to monitor identified ageing related degradation. The maintenance procedures will include specific guidelines to take accurate measurements as well as applicable acceptance criteria for the recorded data. Corrective actions will be updated or formulated to improve any identified gaps in the AMPs.

- 2) The analysis on whether fatigue is a relevant ageing mechanism on the reactor building has been completed and is reported in 2.5245.50/23.259761. It is concluded that no change in the frequency of the leak-rate test is necessary as the mechanical stresses resulting from the leak-rate test are relatively low and given the frequency of tests (less than 100 cycles) over the life of the structure, fatigue caused by the pressure cycles is not a concern.
- 3) The new scope and screening procedure of HFR TLAAs are available on the management system (NO-IB-VE-OD-021937).
- 4) Implementation of the newly identified TLAAs is ongoing. The outcome has resulted in an extensive listing of in-scope TLAAs applicable to relevant HFR SSCs.

**4. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM**

**Date: 04/07/2024**

**4.1 – FACTS:**

**F1)** A review of the civil AMPs is currently ongoing at HFR with a focus on the accuracy and completeness of their contents, including titles, scopes, interfaces/boundaries, materials, service conditions, degradation mechanisms, and applied ageing management strategies.

**F2)** During the follow-up mission, the IAEA team reviewed two civil AMPs (901 on containment steel and 904 on foundations), which were found not yet been updated to include results of the recently performed condition assessments and AMRs.

**F3)** There is an intent to cross reference the AMPs, so that their interface can be addressed. Relevant efforts have been made to some electrical AMPs (e.g. AMP 2530), but not yet to the civil AMPs.

**F4)** References to the procedures for activities to minimize, detect, and mitigate ageing effects are being included in the updated AMPs. The procedures for such activities remain to be updated based on the new findings from AMR.

**F5)** Activities to identify the condition indicators and to determine the acceptance criteria and corrective actions are being performed. For example, a safety case has been developed and resulted in the definition of an acceptable leak rate limit for the pool leakage (NO-O-HFR-OD-011296). The evaluation of repair options is underway and is intended to result in corrective actions. The intent is to include the acceptance criteria in the procedures cross referencing the associated AMPs and specific documents describing the justifications for the acceptance criteria.

**F6)** TLAAs scope review has been performed as documented in NO-IB-VE-OD-021937. Several IGALL TLAAs have been identified as being potentially applicable to HFR civil structures. Evaluations are underway to confirm their applicability or to assess the needs of developing of new TLAAs.

**4.2 – DOCUMENTS REVIEWED:**

- 2.5245.50/23.259761 An Investigation into the Frequency of the Leakage Rate Tests at the HFR. 14 June 2023.
- NO-IB-VE-OD-021937 TLAAs scope review 2023. 20 June 2023.
- NO-IB-VE-OD-020660 AMP 901 -Containment Steel- CSC-CW/AG-0/1. 16 June 2022.
- NO-IB-VE-OD-020663 AMP 904 -Foundation- FND-CW/AG-0/1. 16 June 2022.
- 2.5245.50/24.270996 HFR Buildings Evaluation of the Condition of Safety Related Buildings. June 24 2024.
- NO-M-HFR-OD-021438 PRO-BC033 Buitenschilderwerk koepel.

- NO-IB-VE-OD-022086 AMP 2530 – Pressure Sensors.
- NO-O-HFR-OD-011296 BC-AM52.10 Lakkage in reactorhal.
- NO-M-HFR-OD-021235 PRO-BC-025 Inspectie en reinigen Daken, Kooiladders en valbeveiliging.
- NO-IB-VE-BD-021063 Plan Verouderingsbeheersplan HFR – Betonconstructie.
- NO-M-HFR-OD-0-012204 PRO-M-066 Inspectie betonconstructie Pijpencorridor.

**4.3 – RESOLUTION DEGREE:**

<b>1.</b>	<b>Insufficient progress to date</b>	
<b>2.</b>	<b>Satisfactory progress to date</b>	X
<b>3.</b>	<b>Issue resolved</b>	

## APPENDIX II. AGENDA

### AGENDA OF THE MAIN MISSION

<b>MONDAY, 20 June 2022 – IAEA Team (Hotel)</b>				
<b>15:00– 18:30</b>	<b>IAEA Team Training (IAEA Team Leader)</b> Strengths & weaknesses based on Advanced Information Package review (5 minutes each team member)			
<b>TUESDAY, 21 June 2022</b>				
<b>09:00– 10:30</b>	<b>Entrance meeting: ANVS, NRG/HFR, and IAEA</b> NRG opening remarks and Expectations from the mission ANVS opening remarks and expectations from the mission IAEA opening remarks – review of mission objective, scope, agenda and expected results Ageing management programme/activities, and plans for continued safe operation of HFR (HFR)			
<b>10:30– 12:30</b>	<b>Walkdown of HFR (All – guided by HFR personnel)</b>			
<b>12:30– 13:30</b>	<i>Lunch break</i>			
<b>13:30– 16:30</b>	<b>Review area A/B</b> <b>Presentation of the area status (max. 30 min)</b>  Interview, documents review and discussion IAEA: De Lorenzo & Shokr HFR: Hasa & Stefanini	<b>Review area C</b> <b>Presentation of the area status (max. 30 min)</b>  Interview, documents review and discussion IAEA: Rao & Sun HFR: Blom	<b>Review area D</b> <b>Presentation of the area status (max. 30 min)</b>  Interview, documents review and discussion IAEA: Morris & Petofi HFR: Waard	<b>Review area E</b> <b>Presentation of the area status (max. 30 min)</b>  Interview, documents review and discussion IAEA: Tcherner HFR: de Haan
<b>16:30– 17:00</b>	IAEA team meeting and preparation of daily report (IAEA Team)			
<b>WEDNESDAY, 22 June 2022</b>				
<b>09:00–10:00</b>	Briefing to the Counterparts (IAEA Team Leader)			
<b>10:00–12:30</b>	<b>Review area A/B</b> IAEA: De Lorenzo & Sun HFR: Hasa & Stefanini	<b>Review area C</b> IAEA: Rao HFR: Blom	<b>Review area D</b> IAEA: Morris & Shokr HFR: Waard	<b>Review area E</b> IAEA: Tcherner & Petofi HFR: de Haan
<b>12:30–13:30</b>	<i>Lunch break</i>			
<b>13:30–16:00</b>	<b>Review area A/B</b>	<b>Review area C</b>	<b>Review area D</b>	<b>Review area E</b>

	IAEA: De Lorenzo HFR: Hasa & Stefanini	IAEA: Rao & Petofi HFR: Blom	IAEA: Morris & Sun HFR: Waard	IAEA: Tchner & Shokr HFR: de Haan
<b>16:00–17:00</b>	IAEA team meeting and preparation of daily report (IAEA team)			
<b>THURSDAY, 23 June 2022</b>				
<b>09:00–10:00</b>	Briefing to the Counterparts (IAEA Team Leader)			
<b>10:00–12:30</b>	<b>Review area A/B</b> IAEA: De Lorenzo & Petofi HFR: Hasa & Stefanini	<b>Review area C</b> IAEA: Rao & Shokr HFR: Blom	<b>Review area D</b> IAEA: Morris HFR: Waard	<b>Review area E</b> IAEA: Tchner & Sun HFR: de Haan
<b>12:30–13:30</b>	<i>Lunch break</i>			
<b>13:30–16:00</b>	<b>Review area A/B</b> IAEA: De Lorenzo HFR: Hasa & Stefanini	<b>Review area C</b> IAEA: Rao HFR: Blom	<b>Review area D</b> IAEA: Morris HFR: Waard	<b>Review area E</b> IAEA: Tchner HFR: de Haan
<b>16:00–17:00</b>	IAEA team meeting and preparation of daily report			
<b>FRIDAY, 24 June 2022</b>				
<b>09:00–10:00</b>	Briefing to the Counterparts (IAEA Team Leader)			
<b>10:00–12:30</b>	<b>Review area A/B</b> IAEA: De Lorenzo HFR: Hasa & Stefanini	<b>Review area C</b> IAEA: Rao HFR: Blom	<b>Review area D</b> IAEA: Morris HFR: Waard	<b>Review area E</b> IAEA: Tchner HFR: de Haan
<b>12:30–13:30</b>	<i>Lunch break</i>			
<b>13:30–15:00</b>	<b>Review area A/B</b> IAEA: De Lorenzo HFR: Hasa & Stefanini	<b>Review area C</b> IAEA: Rao HFR: Blom	<b>Review area D</b> IAEA: Morris HFR: Waard	<b>Review area E</b> IAEA: Tchner HFR: de Haan
<b>15:00–16:00</b>	IAEA team meeting and preparation of daily report			
<b>SATURDAY, 25 June 2022</b>				
<b>Free day</b>				
<b>SUNDAY, 26 June 2022 (IAEA Team – Hotel)</b>				
<b>09:30–12:30</b>	Team meeting in the hotel – discussion of issues, recommendations, suggestions and good practices, and development of evaluation section of the report			

<b>12:30–13:30</b>	<i>Lunch</i>
<b>13:30–17:30</b>	Finalization of draft summary report: Drafting of issues, good practices and evaluative section of report – bilateral discussions with IAEA Team Leader
<b>MONDAY, 27 June 2022</b>	
<b>09:00–12:30</b>	Team meeting with counterparts – evaluative section of report - presentation, discussion and agreement by team (counterparts review the issues and good practices)
<b>12:30–13:30</b>	<i>Lunch break</i>
<b>13:30–14:00</b>	Press release to IAEA for comments
<b>14:00–15:00</b>	Finalization drafting issues, recommendations, suggestions, good practices based on comments from counterparts (IAEA team)
<b>15:00–16:00</b>	Debriefing with ANVS
<b>16:00–17:00</b>	Finalization drafting issues, recommendations, suggestions, good practices (IAEA team) based on comments from counterparts – Continuation
<b>TUESDAY, 28 June 2022</b>	
<b>09:00–10:00</b>	Preparation for the exit meeting
<b>10:00–11:30</b>	<b>Exit meeting</b> - (ANVS, NRG/HFR, and IAEA) Mission findings and conclusions (IAEA Team Leader) Detail findings (IAEA team) Closing remarks

#### AGENDA OF THE FOLLOW-UP MISSION

<b>Wednesday, 3 July 2024</b>	
09:30	<b>Entry meeting: Review of mission objectives, expected results, and adoption of agenda</b> HFR: Jelmer Offerein, Core Personnel – Nel, Davis, Best, Blom, van Doorene, Hasa ANVS: Keller (‘Director Competent Authority’), Valkiers IAEA: All – Sun, Chakovski, and Tchnerer
10:00	<b>Presentation from HFR: Implementation status of the safety review recommendations</b> IAEA: All HFR: Core Personnel, presented by Davis
11:00	Coffee Break
11:30	<b>HFR Walkthrough</b> IAEA: All HFR: Nel, Davis, and Best
12:30	Lunch Break

14:00	<b>Review Area A: Organization of Ageing Management and CSO Activities</b> IAEA: All (led by Sun) HFR: Core Personnel
15:30	Coffee Break
16:00	<b>Review Area B: Screening of SSCs and Reactor Programmes</b> IAEA: All (led by Chakovski) HFR: Core Personnel
17:30	Closure for Day 1 & IAEA Team Meeting (Hotel)
<b>Thursday, 4 July 2024</b>	
09:00	<b>Briefing to the Counterparts</b>
09:30	<b>Review Area E: Ageing Management of Civil SSCs</b> IAEA: All (led by Tcherner) HFR: Drenth, Jarvis, and Core Personnel
10:30	Coffee Break
11:00	<b>Review Area E: Ageing Management of Civil SSCs</b> IAEA: All (led by Tcherner) HFR: Drenth, Jarvis, and Core Personnel
12:00	<b>Review Area C: Ageing Management of Mechanical SSCs</b> IAEA: All (led by Sun) HFR: Jacobs, Piccolo, and Core Personnel
12:30	Lunch Break
14:00	<b>Review Area C: Ageing Management of Mechanical SSCs</b> IAEA: All (led by Sun) HFR: Jacobs, Piccolo, and Core Personnel
14:30	<b>Review Area D: Ageing Management of Electrical and I&amp;C SSCs</b> IAEA: All (led by Chakovski) HFR: Haarsma, Visage, Drenth, and Core Personnel
15:30	Coffee Break
16:00	<b>IAEA Team Meeting</b> IAEA: All
16:30	<b>Briefing to the Counterparts</b>
17:00	<b>Debriefing with ANVS</b> ANVS: Jansen, Sijbrands
17:30	Closure for Day 2

<b>Friday, 5 July 2024</b>	
09:00	<b>Finalization of Draft Summary Report &amp; Preparation for Exit Meeting</b> IAEA: All
12:30	Lunch Break
14:00	<b>Exit Meeting: Mission Conclusions and Closing Remarks</b> IAEA: All HFR: Leeftink, Offerein, and Core Personnel ANVS: van Bolhuis and van Rixel
18:00	<b>Social diner</b> HFR: Offerein and Core Personnel IAEA: Sun and Tchnerer ANVS: Keller and van Rixel ('Team leader 'Office for Executive Affairs')