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REPORT OF THE

FOLLOW-UP INTEGRATED SAFETY ASSESSMENT OF RESEARCH REACTORS (FOLLOW-UP INSARR) MISSION

TO THE

HOGER ONDERWIJS REACTOR (HOR)

Delft University of Technology
Delft, Netherlands, Kingdom of the
15 – 18 April 2024

DEPARTMENT OSF NUCLEAR SAFETY AND SECURITY
Division of Nuclear Installation Safety
Research Reactor Safety Section

INTERNATIONAL ATOMIC ENERGY AGENCY

Mission date:	15 – 18 April 2024	
Location:	Delft, Netherlands, Kingdom of the	
Facility:	Hoger Onderwijs Reactor (HOR)	
Organized by:	IAEA at the request of the Authority for Nuclear Safety and Radiation Protection (ANVS), Netherlands, Kingdom of the	
Conducted by:	Mr Kaichao Sun	IAEA (Team Leader)
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EXECUTIVE SUMMARY

Following a request from the Authority for Nuclear Safety and Radiation Protection (ANVS), the Dutch regulatory body, the IAEA conducted a Follow-up Integrated Safety Assessment of Research Reactors (INSARR) mission to the Hoger Onderwijs Reactor (HOR) in the Delft University of Technology (TU Delft), the Kingdom of the Netherlands, from 15 to 18 April 2024. The main INSARR mission was conducted from 7 to 14 September 2021. HOR is an open pool-type research reactor, owned by the TU Delft and operated by its Reactor Institute Delft (RID). The reactor is mainly utilized for neutron physics, medical radioisotope production, neutron activation analysis, materials irradiation, and education and training.

The mission team comprised an IAEA staff, Mr K. Sun (Nuclear Safety Officer, Research Reactor Safety Section (RRSS) – Team Leader), and two international experts: Mr N. De Lorenzo (Argentina) and Mr D.V. Rao (India). The main technical counterpart of the mission was Mr C. Kaaijk, Head of HOR-O (Department of HOR Development), RID. RID and HOR management and technical staff, and several members of the TU Delft, Radiation Science and Technology department participated in the mission. ANVS representatives participated in the mission as observers.

The IAEA team concluded that RID achieved a high level of implementation of the recommendations and suggestions of the main INSARR mission. The team assessed that 19 out of 22 recommendations have been either fully implemented or minor actions remain for their full implementation. The mission identified the need for full implementation of the other three INSARR recommendations, noting that actions have been taken or planned to address them. In addition, the results of the analysis for RID organizational restructuring options led to a new recommendation. The team also noted that all five suggestions of the main INSARR mission were considered by RID, and significant actions have been taken for their implementation.

The IAEA team assessed that this high level of implementation of the INSARR recommendations contributes to further enhancement of the reactor safety, through strengthened organizational effectiveness, safety analysis and safety documents, and operating programmes and safety aspects of technical modifications of the facility, including:

- Strengthened safety culture by development of a programme with the support of external specialist that included identification of the main safety goals for the operating organization and elevation of risk awareness using a systematic assessment;
- Completed analysis for RID organizational restructuring options and clarification of roles and responsibilities by updating the job descriptions of the director of RID and heads of HOR-O and HOR-B (Department of HOR Operation);
- Improved function of HOR safety committee with an established list of items to be reviewed in accordance with IAEA Safety Standards Series No. SSR-3 and establishing detailed terms of reference;
- Revised operational limits and conditions (OLCs) with clear distinctions between safety limits and safety system settings to ensure sufficient safety margins;
- Updated of the safety analysis report (SAR) and enhanced its format in accordance the IAEA Safety Standards Series No. SSG-20 (Rev. 1);
- Development and implementation of a retraining programme for the operating personnel following the major modifications;

- Improved radioactive waste management and maintenance programmes, including ageing management programme, through establishment of a new asset management tool (Archibus);
- Established categorization process based on the safety significance of the utilization and modification projects to determine their routes for approval and procedures for implementation.

Three INSARR recommendations remain valid and further actions are needed for their implementation. These recommendations are related to the need for further improvement of the safety analysis by re-evaluation of the fuel channel blockage event; revision of the system for area classification and zoning for radiological protection by taking into consideration the laboratories located within the reactor site; and re-establishment of the requirements on maintenance, periodic testing and inspection as part of the OLCs during the reactor prolonged shutdown period.

The new recommendation was provided on the need to complete the training programme for the newly appointed director of RID, who carries out the role of reactor manager.

The follow-up mission results were discussed with the RID management and the reactor operating personnel during the exit meeting held on the last day of the mission, with the participation of the ANVS, including Ms A. van Bolhuis, chair of the board. There was general agreement by the counterparts on the mission conclusions.

The IAEA team appreciated the openness and transparency of the RID management and the HOR operating personnel and acknowledged their technical knowledge and excellent preparation for the mission. The team also would like to express its appreciation to the ANVS and RID for their commitment to safety and continuous improvement.

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1. INTRODUCTION

1.1 BACKGROUND

Following a request from the Authority for Nuclear Safety and Radiation Protection (ANVS), the Dutch regulatory body, the IAEA conducted a Follow-up Integrated Safety Assessment of Research Reactors (INSARR) mission to the Hoger Onderwijs Reactor (HOR) in the Delft University of Technology (TU Delft), the Kingdom of the Netherlands, from 15 to 18 April 2024. The main INSARR mission was conducted from 7 to 14 September 2021.

HOR is an open pool-type research reactor, owned by the TU Delft and operated by its Reactor Institute Delft (RID). The reactor uses low enriched MTR fuel. The core is composed of 16 fuel assemblies and 4 control assemblies, with 4 control rods. It is equipped on three sides with a row of beryllium reflector assemblies acting as neutron reflectors. The reactor provides neutron radiation to a variety of facilities for radioisotope production and neutron activation analysis. It is also equipped with six horizontal beam-tubes in two sets of three at opposite sides of the core, and a tangential beam tube, mainly used for neutron scattering experiments. The reactor is licensed for maximum of 3 MW and is typically operated between 4 to 5 days a week at 2.3 MW. HOR is mainly utilized for neutron physics (mainly scattering experiments via beam tubes), medical radioisotope production, neutron activation analysis, materials irradiation, and education and training.

HOR achieved criticality for the first time in 1963 and went through several modifications and upgraded during its lifetime, including power upgrade to 3 MW (1967), conversion from highly enriched uranium to low enriched uranium fuel (2005), and refurbishment of the instrumentation and control system (2010). In 2013, RID started the Oyster project to design, construct and install a cold neutron source (CNS) at HOR. The project includes the modification of the R1 and R2 beam tubes to accommodate a CNS. The CNS installation was implemented in two phases. Phase 1 is the R2 extension tube installation. In this regard, HOR was shutdown from May 2019 to December 2021. In October 2023, HOR was shutdown again to complete Phase 2. Reactor operation was resumed for the CNS commissioning the week before this mission.

1.2 OBJECTIVE AND SCOPE OF THE MISSION

The objective of the follow-up INSARR mission was to review the level of implementation of the recommendations and suggestions of the main INSARR mission conducted in 2021 and to evaluate the safety improvements since that mission.

The scope of the follow-up INSARR mission covered the safety areas that are associated with recommendations or suggestions from the main INSARR mission. These areas are as follows:

- Regulatory supervision;
- Operating organization and reactor management;
- Safety committee;
- Training and qualification programme;
- Safety analysis;
- Safety analysis report;
- Operational limits and conditions;
- Conduct of operations;
- Maintenance, periodic testing and inspection;

- Safety of modifications;
- Safety of utilization and experiments;
- Radiation protection;
- Radioactive waste management;
- Emergency planning;
- Safety culture.

1.3 BASIS FOR THE ASSESSMENT

The basis for the safety review of HOR reactor is the IAEA Safety Standards. The following IAEA documents were used as the basis of this review:

a) Safety of Research Reactors, IAEA Safety Standards Series No. SSR-3, IAEA, 2016;
b) Leadership and Management for Safety, IAEA Safety Standards Series No GSR Part 2, IAEA, 2016;
c) Commissioning of Research Reactors, IAEA Safety Standards Series No. SSG-80, IAEA, 2023;
d) Maintenance, Periodic Testing and Inspection of Research Reactors, IAEA Safety Standards Series No. SSG-81, IAEA, 2023;
e) Core Management and Fuel Handling for Research Reactors, IAEA Safety Standards Series No. SSG-82, IAEA, 2023;
f) Operational Limits and Conditions and Operating Procedures for Research Reactors, IAEA Safety Standards Series No. SSG-83, IAEA, 2023;
g) The Operating Organization and the Recruitment, Training and Qualification of Personnel for Research Reactors, IAEA Safety Standards Series No. SSG-84, IAEA, 2023;
h) Radiation Protection and Radioactive Waste Management in the Design and Operation of Research Reactors, IAEA Safety Standards Series No. SSG-85, IAEA, 2023;
i) Ageing Management for Research Reactors, IAEA Safety Standards Series No. SSG-10 (Rev. 1), IAEA, 2023;
j) Safety Assessment for Research Reactors and Preparation of the Safety Analysis Report, IAEA Safety Standards Series No. SSG-20 (Rev. 1), IAEA, 2022;
k) Use of a Graded Approach in the Application of the Safety Requirements for Research Reactors, IAEA Safety Standards Series No. SSG-22 (Rev. 1), IAEA, 2023;
l) Safety in the Utilization and Modification of Research Reactors, IAEA Safety Standards Series No. SSG-24 (Rev. 1), IAEA, 2022;
m) Instrumentation and Control System and Software Important to Safety for Research Reactors IAEA Safety Standards Series No. SSG-37 (Rev. 1), IAEA, 2023.

Several safety and operating documents, particularly the “Progress Report HOR: Follow-up INSARR 2021, Version March 2024” (referred as “the Progress Report” in the following sections, that have been developed in support of implementation of the recommendations and suggestions of the main INSARR mission were also reviewed during the mission.

1.4 CONDUCT OF THE MISSION

The mission team comprised an IAEA staff, Mr K. Sun (Nuclear Safety Officer, Research Reactor Safety Section (RRSS) – Team Leader), and two international experts: Mr N. De

Lorenzo (Argentina) and Mr D.V. Rao (India). The main technical counterpart of the mission was Mr C. Kaaijk, Head of HOR-O (Department of HOR Development), RID. RID and HOR management and technical staff, and several members of the TU Delft, Radiation Science and Technology department participated in the mission. ANVS representatives participated in the mission as observers.

The entry meeting started with a welcome address by Mr W. Koppers, the director of RID and Mr B. Keller, director of competent authority department, ANVS. In their opening remarks, they highlighted the background of the request for the follow-up INSARR mission, the importance to safety of international peer reviews, and the cooperation of RID and ANVS with IAEA on safety of research reactors. During the opening session, the RID management provided an overview of the safety status of the reactor and the major activities implemented since the main INSARR mission. The IAEA team leader reviewed the mission objectives, scope, and expected results.

During the mission, the following activities were performed:

- Examination and assessment of technical documentation;
- A detailed walkthrough of the reactor facility;
- Discussions with the RID management and the reactor operating personnel;
- Debriefing to the ANVS;
- Discussions among IAEA team members;
- Preparation of the mission summary report and the draft mission report.

The follow-up mission conclusions were discussed with the RID management and the reactor operating personnel during the exit meeting held on the last day of the mission, with the participation of the ANVS, including Ms A. van Bolhuis, chair of the board. There was general agreement by the counterparts on the mission conclusions.

The agenda of the mission is provided in ANNEX I and the full list of participants is provided in ANNEX II.

2. CONCLUSIONS AND RECOMMENDATIONS

The IAEA team concluded that RID achieved a high level of implementation of the recommendations and suggestions of the main INSARR mission. The team assessed that 19 out of 22 recommendations have been either fully implemented or minor actions remain for their full implementation. The findings from the IAEA mission indicated the needs of continued safety enhancements in the implementation of the other three INSARR recommendations, although activities have been implemented or considered for addressing them. In addition, the results of the analysis for RID organizational restructuring options led to a new recommendation. The team also noted that all five suggestions of the main INSARR mission were considered by RID, and significant actions have been taken in the implementation of these suggestions.

The IAEA team concluded that this high level of implementation of the INSARR recommendations contributes to further enhancement of the reactor safety, through strengthened organizational effectiveness, safety analysis and safety documents, and operating programmes and safety aspects of technical modifications of the facility. The team stressed the fact that, as some INSARR recommendations are of an ongoing nature, RID needs to continuously monitor the effectiveness of the established measures.

The IAEA team assessed that RID has strengthened the organizational effectiveness through:

- Enhancement of the safety culture by development of a programme with the support of external specialist that included identification of the main safety goals for the operating organization and elevation of risk awareness using a systematic assessment. The IAEA team highlighted the ongoing nature with respect to maintaining a robust safety culture;
- Completion of analysis for RID organizational restructuring options and clarification of roles and responsibilities by updating the job descriptions of the director of RID and heads of HOR-O and HOR-B (Department of HOR Operation);
- Establishment of administrative process to maintain functional independence with regard to the personnel swapping their function between operation and maintenance and to assure independence of the quality assurance function from the reactor management;
- Further improvement of the function of HOR safety committee with an established list of items to be reviewed in accordance with IAEA Safety Standards Series No. SSR-3 and detailed terms of reference.

With respect to safety analysis and safety documents, the IAEA team assessed that the implementation of the INSARR recommendations resulted in:

- Revised operational limits and conditions (OLCs) with clear distinctions between safety limits and safety system settings to ensure sufficient safety margins. A new design limit has been introduced based on the analysis of onset of flow instability for steady state conditions;
- Significant progress in the alignment of the SAR structure with the IAEA Safety Standards Series No. SSG-20 (Rev. 1) and inclusion of the up-to-date facility information, such as recent major modifications and revised results of safety analysis and OLCs. A work plan for periodically updating the SAR in future, based on current revision experience, has also been established.

The IAEA team also assessed that RID has implemented actions involving operating programmes and technical modifications of the facility that resulted in improved:

- Training programme with respect to development and implementation of a retraining programme for the operating personnel following the major modifications and prolonged shutdown period. The retraining programme, including a formal re-qualification process, has also been implemented for those personnel who have not performed their licensed duties for more than six months;
- Operational safety through revised operating procedures and work instructions taking into account the major modifications associated with the CNS prior to its commissioning and through a recently established work permit system;
- Radioactive waste management and maintenance programmes, including ageing management, through establishment of a new asset management tool (Archibus). An inventory of unused and stored experimental equipment in the reactor pool has been established with annual assessment of disposal needs. The tool is also used to improve management of obsolescence and spare parts;
- Categorization process based on the safety significance of the utilization and modification projects to determine their routes for approval and procedures for implementation. Clear criteria were established to distinguish between routine replacement and modification of SSCs important to safety;
- Emergency preparedness through training of the response teams, including operating personnel, and through periodically conduction of emergency drills.

The findings from the IAEA mission indicated the need for full implementation of three INSARR recommendations, which remain valid, that are related to:

- Further improvement of the safety analysis by re-evaluation of the fuel channel blockage event, particularly with respect to the validity of the computational tools and models used;
- Revision of the system for area classification and zoning for radiological protection by taking into consideration the laboratories located within the reactor site and investigation of the need for installing charcoal filters in the ventilation system;
- Re-establishment of the requirements for maintenance, periodic testing and inspection as part of the OLCs during the reactor prolonged shutdown period and reassessment of the needs for developing a specific set of OLCs associated with the CNS commissioning.

The new recommendation that was resulted from the analysis for RID organizational restructuring options is as the following:

- The training programme for the newly appointed director of RID, who serves the role of reactor manager, should be completed and the outcome of this training should be assessed to ensure the technical competencies needed to effectively fulfil the direct responsibility for safety, including making arrangements for all activities related to core management and fissile materials handling.

The IAEA team appreciated the openness and transparency of the RID management and the HOR operating personnel and acknowledged their technical knowledge and excellent preparation for the mission. The team also would like to express its appreciation to the ANVS and RID for their commitment to safety and continuous improvement.

3. RESULTS OF THE MISSION

3.1 FACILITY WALKTHROUGH

During the first day of the mission, the IAEA team conducted a detailed walkthrough of HOR. The walkthrough was an opportunity to verify in the field the physical status of the reactor facility and the progress made regarding the implementation of some of the INSARR recommendations.

The HOR was in shutdown during the walkthrough, but it was prepared for startup to conduct low power commissioning tests later in the day. The IAEA team noted improvements in operational radiation protection. For example, the risk of contamination was reduced by providing lab coats before entering the reactor hall and by not permitting visitors to bring in personal items by hands. Additionally, the information covered by the safety instruction for the visitors reflected the up-to-date conditions and physical status of the HOR facilities. However, the IAEA team noted inconsistency in the radiological protection area classification (see Section 3.2.9 of this report)

The IAEA team also visited the control room and discussed with the operating personnel the changes due to the CNS commissioning. The on-duty operator demonstrated adequate knowledge of the recently installed systems associated with CNS and of the responses to anticipated operational occurrences. The team also noted improvements of the housekeeping in the control room compared with that observed during the main INSARR mission.

In the experimental hall, the beam lines were observed to be in good conditions, with experimental stations ready for the commissioning measurements.

In the piping corridor, the recently replaced primary and secondary cooling circuits were observed to be in good conditions. Although a lead wall has been installed in front of the entire coolant system, for protecting against short lived activation products in the primary coolant, signs for indicating (potential) radiological areas and measures for preventing spread of (potential) leakage of contaminated are not implemented.

3.2 FOLLOW-UP OF THE IMPLEMENTATION OF THE RECOMMENDATIONS OF THE INSARR MISSION

The following subsections present the results of the follow-up of the implementation of the INSARR mission. The presented results correspond to all safety areas that were covered by the scope of the follow-up mission. The recommendations and suggestions from the INSARR mission is quoted in each subsection with *italic* font, followed by discussions of the actions that have been taken by RID. The IAEA team's observations and conclusions are described following the "Implementation" title. Additionally, the IAEA team identified a gap in the review area of "Operating organization and reactor management" during this mission and provided a recommendation to address this, which is provided at the end of the relevant subsection under "Recommendations of this mission".

3.2.1 Regulatory supervision

"**S1)** *The RID is suggested to communicate with the regulatory body for a practical solution to minimize the functional conflict and confusion between SAR and SR as well as the potential inconsistency due to each individual amendment in the licensing process."*

Implementation

RID communicated with ANVS on the status of the safety analysis report (SAR) and safety report (SR) and concluded that there was no confusion between these two documents in relation to the licence process. RID also mentioned that SAR and SR are required consistently for all nuclear installations in the Kingdom of the Netherlands. RID and ANVS have agreed that no change is needed for such arrangement.

The IAEA team concluded that the suggestion has been considered by RID and sufficient actions have been taken for the implementation.

3.2.2 Safety culture

"**R1)** *RID should establish, advocate, and adhere to an organizational approach to safety that establishes behavioural expectations, institutional and individual values, and the acceptance of personal accountability in relation to safety. In this regard, RID is recommended to:*

- *Develop a vision and strategy for defining, communicating, and monitoring safety culture;*
- *Assign a senior leadership role with defined responsibilities regarding safety culture programme, including communications of safety issues and continuous improvement."*

"**S2)** *RID is suggested to:*

- *Formalize and continue efforts to follow up on the safety culture survey report;*
- *Continuously develop processes and tools that consider the interactions between human and organization factors in procedure development, event analysis, and proposed changes."*

"**S3)** *Formal training regarding the aspects of nuclear safety and safety culture (raising concerns across functions and levels, questioning attitude, and learning from external experience) should be made available."*

Implementation

A new job description issued in January 2024 clarifies that the ownership of the safety culture programme lies with the director of RID, who also serves the role of reactor manager. A working group aiming to develop vision and strategy to continuously enhance the RID safety culture was formed and the kick-off meeting was organized in February 2022. The goals of this working group were set to improve 1) risk awareness, 2) learning, and 3) compliance. Organizational measures have been taken to further develop clear lines of responsibility and ownership as well as sufficient capacity and competences. For example, the former RID department of SBD (i.e. radiation protection) has been split into three units: SBE (radiation protection unit with a focus on operational radiation safety), ASD (radiation protection expert at TU Delft with a focus on advice and policy making), and V&B (safety and security with a focus on occupational safety, environment and security). The heads of all three units directly report to the director of RID. In addition, the total staffing has been increased compared with that at the time of the main INSARR mission by about three full time staff equivalents to address the needs related to the safety culture programme.

A communication plan was developed for the RID staff and involved students from TU Delft. The plan has been implemented since 2022 on safety topics, such as safe use of chemical substances. Different communication channels have been applied to the plan, including via

printed posters and via TU Delft networks. All the communications share a common visual style, and they are labelled with the same campus safety motto: Safe Secure for Sure.

Retraining activities on nuclear safety and safety culture have been included in the training programme. A new process has been established to facilitate HOR operational experience feedback and the corresponding database has been made operational. A training session on root cause analysis, provided by Joint Research Centre, was organized for the RID staff in 2023. Further improvement of the RID internal root cause analysis has been integrated in the facility unusual events process.

The IAEA team concluded that sufficient actions are being taken to address the INSARR recommendation and that the relevant issues are closed. Additionally, the two suggestions in this review area have also been considered by RID with sufficient actions having been taken.

3.2.3 Operating organization and reactor management

"**R2)** *In view of the considered restructuring of the organization of HOR operation, adequate analysis should be performed (and measures taken accordingly), in accordance with approved procedures that supplement the existing TU Delft procedures on organizational changes, on safety implications of the proposed changes including on roles and responsibilities for safety of positions in particular with respect to leadership and management for safety. The analysis should be subjected to review by the reactor safety committee and to ANVS review and assessment."*

Implementation

Following the main INSARR mission in 2021, RID organizational restructuring options have been analysed, including separating the role of reactor manager from the director of RID. The result of the analysis was to keep the arrangement of the leadership and management for safety unchanged, i.e. the director of RID serving the role of reactor manager. A "reactor management meeting" has been established and implemented periodically (usually monthly) with the participation of the director of RID and the heads of HOR-O and HOR-B (Department of HOR Operation). The topics of such a meeting cover safety related activities, including core management, new experiments, training and qualification, and continuous development of safety culture. The job descriptions for the director of RID as well as for the heads of HOR-O and HOR-B have been updated to clarify their roles in the HOR management. The direct responsibility for safety has been highlighted in the job description for the director, i.e. as the role of reactor manager. The Progress Report indicated that the new set of job descriptions are subjected to safety committee review and ANVS approval. The IAEA team noted that a new director of RID was appointed by the TU Delft executive board in September 2023 and many of the above-mentioned activities have been initiated since the new leadership. The new director is currently going through a training programme developed for executing the authorized safety functions.

The IAEA team assessed that the newly developed job descriptions for the director of RID are in line with the expected safety responsibilities for a reactor manager. The IAEA team, however, observed that some of these safety responsibilities are currently not fully implemented, since the necessary training on nuclear engineering and HOR operational safety is still in progress for the director of RID. As of the time of the follow-up mission, the "reactor management meeting" is mainly a means of informational communication, rather than a part of a decision-making process. The IAEA team verified that the director of RID approves new reactor experiments but does not directly authorize the HOR core configuration changes.

The IAEA team concluded that sufficient actions are being taken to address the INSARR recommendation and the original issue on the analysis of organizational restructuring options can be considered closed. The results of such analysis, however, led to a new IAEA team recommendation.

Recommendation of this mission:

R1) The director of RID should effectively fulfil the safety responsibilities associated with the reactor manager role by completion of the necessary training and exercising the authority for the safe operation of the HOR, including making arrangements for all activities related to core management and fissile materials handling.

"**R3)** *The organization structure of the HOR operation should be improved by:*

- *Establishing adequate measures and practical arrangements to ensure effective quality verification of the activities important to safety that are carried out by the reactor operators swapping their functions between operation and maintenance;*
- *Ensuring the independence of the quality assurance function from reactor management;*
- *Formalizing the HOR safety committee position in the organizational structure, with a clear description of its role, function, and line of communications."*

Implementation

RID established an administrative process, aiming not to swap reactor operators functions between operation and maintenance. The process formalizes that the operators on duty will not carry out any maintenance tasks; The process also formalizes that the off-duty operators (who are not on duty during working hours) may conduct works on small projects but not any maintenance tasks. During reactor shutdown, the reactor operators may perform certain maintenance tasks, such as instrument calibrations, with independent quality checks and verification; but not any maintenance tasks related to mechanical and chemical systems, such as pumps, water treatment system, and cooling towers. The latter will be solely performed by HOR technical group. In additional, the process requires that maintenance work performed on SSCs important to safety is verified by different personnel (i.e. 4-eye principle).

The integrated management system (IMS) manager, who has a direct communication channel to the director of RID, is now promoted to the department head level at RID. The arrangement aims to ensure that the quality assurance function is independent from the HOR-B, i.e. Department of HOR Operation, and the radiation protection unit.

The HOR safety committee has been added in the RID organizational structure. The terms of reference have been updated with clear descriptions of its function (see Section 3.2.4). The committee advises the director of RID. Following the discussion during the follow-up mission, RID agreed to include in the organizational structure for the reactor operation a communication line between the TU Delft executive board and the HOR safety committee.

The IAEA team concluded that sufficient actions have been taken to implement this recommendation and that the relevant issues are closed.

3.2.4 Safety committee

"**R4)** *The functioning of the HOR safety committee should be further improved by:*

- *Revising the list of the safety documents to be submitted to the committee for review in accordance with the IAEA safety standards No. SSR-3;*

- *Establishing working instructions for the committee, including procedures for dealing with situations where consensus is not achieved, and procedures to ensure effective follow-up on the implementation of the Committee's recommendations."*

Implementation

The list of the safety documents to be submitted for the HOR safety committee review has been updated in accordance with the IAEA Safety Standards Series No. SSR-3. For example, the proposed new tests and experiments under HOR safety class 1, 2, or 3 are included. Any reports of abnormal incidents, including events that are required to be reported to ANVS and any violations of OLCs, are included. Any modification of or new procedures are also included.

The working instructions for the safety committee have also been updated. In particular, the procedure to deal with a situation where consensus has not been achieved was established. It has been decided that in the case of situations where no consensus has been achieved, advice is suspended until unanimous advice can be reached following additional information or consultation from external experts. A procedure on follow-up on the implementation of the committee's recommendations was also established through regularly reviewing the minutes of the committee's meeting. In addition, two new members outside RID have been added to the safety committee (one on safety culture and one on material science), in order to further enhance the technical competence as well as independence from the reactor management.

The IAEA team concluded that sufficient actions have been taken to implement this recommendation and that the relevant issues are closed.

3.2.5 Safety analysis

"**R5)** *The safety analysis should be further improved by re-evaluation of the fuel channel blockage event, particularly with respect to the validity of the used computational tools and models, and by identification (and inclusion of its description in SAR) of the limiting event defining the maximum reactivity worth of fixed experiments."*

Implementation

Following the main INSARR mission, a study (master thesis project) was conducted at TU Delft aiming to investigate the validity of the point kinetics model for the safety analysis of the fuel channel blockage event at HOR. This study was completed in June 2023 and was provided to the IAEA team. In this study, neutronics results for a single HOR fuel element located in an infinite space have been compared between Monte Carlo and deterministic methods. In addition, a simplified heat transfer model has been developed to analyse the timescale of temperature propagation when coolant boiling occurs within a HOR fuel channel. The main conclusion of this study was that when a HOR transient is initiated by the fuel channel blockage, the physical phenomena of significant coolant boiling (e.g. reaching 50% voidage) within the fuel channel could take place in less than 0.1 second. The IAEA team acknowledged the efforts of this study, but also indicated the conclusions of such a research work cannot be considered as the evidence "with respect to the validity of the used computational tools and models", i.e. a point kinetics code (namely RELAP5) being applied to the analysis of a highly heterogenous spatial problem (i.e. local boiling following the fuel channel blockage event).

During the follow-up mission, the counterpart also presented a doctoral thesis, which was completed at TU Delft in 1996. The thesis investigated the spatial effects in nuclear reactor kinetics. The counterparts explained that the research investigation served as the technical basis for the HOR trip setup based on excessively negative reactivity changing rate (or called

"margin indicator exceeds 100%"). The IAEA team acknowledged the clarification but explained that the functionality of the HOR trip setup is not the issue that led to the INSARR recommendation, but rather the "validity of the used computational tools and models" used in the SAR for the analysis of the fuel channel blockage event. The IAEA team further explained that the SAR claimed such accident can be protected by a reactor trip triggered by a small reactivity transient of about 40-50 pcm (due to a local boiling within one or several coolant channels). The key issue is not when such small reactivity is inserted, whether the reactor trip can function or not. Instead, the issue is to verify how credible is the 40-50 pcm reactivity effect calculated by the point kinetics model based on pre-prepared cross-sections. Additional efforts are thus needed for such verification.

Regarding the recommendation on identifying the limiting event for the maximum reactivity worth of fixed experiments, the counterparts, following the investigation of the current OLCs, decided to remove this specification and will update the safety documents accordingly. All future fixed experiments will thus be analysed as part of the safety evaluation for the core configuration change. The safety evaluations will be submitted for regulatory review and assessment.

The IAEA team concluded that the implemented actions are sufficient to address the recommendation with respect to identification of the limiting event defining the maximum reactivity worth of fixed experiments. However, the part related to "validity of the used computational tools and models" for fuel channel blockage event remains valid and needs to be implemented.

"**S4)** *The safety analysis needs to be performed using the as-built experimental facilities, and the SAR needs to be revised accordingly."*

Implementation

Chapter 16 of the SAR analysed a hypothetical experiment for a uranium loop test. The analysis adopted conservative assumptions, which envelopes the safety cases of all other in-pile experiments (proposed and conducted) at HOR. Such analytical approach has been communicated with ANVS and positive feedback has been received. RID decided to keep the SAR unchanged accordingly.

The IAEA team concluded that the suggestion has been considered by RID and sufficient actions have been taken for the implementation.

3.2.6 Operational limits and conditions

"**R6)** *Surveillance requirements and periodic testing (as part of the OLCs) that were waived during the reactor prolonged shutdown period should be re-established unless it is adequately justified based on a comprehensive safety analysis considering the status of the facility, documented, and subjected to review and approval of the regulatory body. New experiments and modifications as well as associated commissioning plans for restart of the reactor should be evaluated to reassess the need for improvements or changes to OLCs. The OLCs should constitute an envelope for which reactor safety parameters and SSCs conditions are demonstrated to be safe and that the site personnel and public are protected against radiation. These OLCs could be subjected to revision based on the commissioning of new experiments and modifications."*

Implementation

The counterparts provided additional clarifications and the reference procedures regarding the process of assessment for the existing OLCs in case of new experiments and modifications. Project-based (with an established management system) and non-project-based (mostly apply to temporary measures) OLCs adjustments have been introduced. When OLCs modifications become necessary, review by the HOR safety committee and approval by regulatory body may be applicable. A new specification, which is associated with the CNS related modifications, has been added to the OLCs for HOR operation. However, no actions have been implemented to re-establish OLCs by taking into consideration the two recent prolonged shutdown periods and the ongoing commissioning tests. The counterpart did not provide any additional justifications that certain requirements for maintenance and periodic testing were waived during the prolonged shutdown periods.

The IAEA team concluded that this recommendation remains valid, and the relevant issue still needs to be resolved and observed in future HOR activities.

"**R7)** *The OLCs should be revised in accordance with the IAEA safety standards No. SSR-3 to include safety limits and safety system settings. As OLCs are included in a separate document, a summary of these OLCs should be included in the SAR with a reference to that separate document."*

Implementation

A revised version for the section of safety limits in the OLCs have been provided to the IAEA team. The revision avoided duplicated values between the safety limits and the safety system settings. Adequate safety margin has been kept. The safety limits have been specified to ensure the peak cladding temperature does not exceed its maximum allowed value of 400 ℃. The corresponding sets of operational parameters (such as reactor power, inlet coolant temperature, mass flow rate, and water level) have been determined based on the onset of flow instabilities, which conservatively ensures sufficient cooling to the fuel cladding. The safety system settings have been selected within the envelop established for the safety limits. A summary of the revised OLCs, once approved by ANVS, is to be included in the SAR.

The IAEA team concluded that sufficient actions have been implemented to address this INSARR recommendation and that the relevant issues are closed.

3.2.7 Safety analysis report

"**R8)** *Updating of the SAR, which is being performed by RID, should be taken as an opportunity to further improve its contents and comprehensive nature as the main document on the safety of the facility by including up-to-date information on modifications, integrating all necessary technical information (e.g., OLCs) and resolving any potential inconsistencies including with other facility's documentation. The SAR should be periodically updated to reflect modifications made to the facility and on the basis of experience and in accordance with regulatory requirements."*

Implementation

Following the main INSARR mission, review of the SAR was conducted by the RID staff. A revision plan was developed, and coordinators were assigned for each SAR chapter. A Gantt chart following the revision progress was presented to the IAEA team. Significant progress was achieved in revision of the majority of the SAR chapters. In particular, the information associated with the recent HOR modifications that relevant to the CNS has been incorporated.

Changes were also made to reflect the up-to-date OLCs and emergency preparedness. In addition, a five-year periodic review cycle of the SAR has been established for future revisions.

The IAEA team concluded that sufficient actions have been implemented to address this INSARR recommendation and that the relevant issues are closed.

3.2.8 Training and qualification programme

"**R9)** *A training programme for the reactor operating personnel should be developed and implemented for restart of HOR operation after the prolonged shutdown period. This programme should include items such as modifications and changes to the reactor systems and components, safety documents, procedures that are not frequently performed, selected topics from the initial training programme, and operating experience feedback from the reactor and other similar facilities."*

"**R10)** *A formal re-qualification process should also be established, and implemented before restart of reactor operation, for operating personnel who have not performed their duties for long periods (suggested more than 6 months)."*

Implementation

A retraining plan has been developed since completion of the main INSARR mission to address the potential knowledge gap due to the prolonged shutdown periods during the OYSTER project. The plan was approved by the director of RID in May 2023 and has been implemented since then. This retraining plan complements the initial training for new staff and the existing retraining programme, which is conducted for the reactor operating personnel twice per year and covers operating experience feedback at HOR and at other similar facilities. The HOR operating personnel are required to complete the retraining plan if they have not performed their duties (i.e. participated in reactor operation) for more than six months. The plan consists of four action steps: 1) Self-study, 2) computer-based tests, 3) practical check-outs, and 4) examination by an internal committee. A list of training materials, such as reactor start-up and shutdown procedures and instrumentation calibration checkouts, has been included in the plan, which is accessible to the RID staff via the online management system. A record keeping card to formalize the re-qualification process is also available. Evidence of the records and the training material were presented to the IAEA team during the mission.

The counterparts also indicated that there are separate training sessions, mandatory for all operating personnel and other relevant radiation protection staff, providing information on the facility modifications due to the OYSTER project. The IAEA team explained that it is encouraged to combine all the retraining needs, including the existing retraining activities (i.e. the regular sessions arranged twice per years), the dedicated training sessions related to the CNS modifications, and the re-qualification process following extended absence, into a comprehensive programme that is subjected to the requirements of the HOR integrated management system.

The IAEA team concluded that sufficient actions have been implemented to address **R9)** and **R10)** and that the relevant issues are closed.

3.2.9 Radiation protection

"**R11)** *Assessment of the radiological hazards within the reactor building should be performed based on the facility's actual status. Adequate radiological protection measures (including workplace contamination monitoring) should be established accordingly. This includes assessment of the likelihood and magnitude of possible airborne releases, and investigation of*

the need for installation of charcoal filtering system for protection of reactor personnel as well as the environment."

Implementation

Since the main INSARR mission, RID has added two new senior staff in the area of radiation protection, namely the radiation protection expert (ASD) since July 2023 and head of radiation protection unit (SBE) since September 2023. This has enabled the implementation of several actions to improve the radiological safety of the reactor. For example, the HOR radiation protection programme has been updated to reflect the major modifications of the facility. In addition, an internal dosimetry monitoring programme has been established and its implementation is expected in the second half of 2024. RID also procured new aerosol monitoring systems, which were under the testing phase by the time of the follow-up mission. This capability will contribute to the assessment during possible airborne releases. The need for installation of charcoal filtering system, however, has not yet been investigated.

During the week prior to the IAEA mission, the first set of cold neutron measurements were completed at the reflectometer. The RID staff mentioned that additional radiation surveys are planned as part of the CNS commissioning tests at reduced reactor power levels.

The IAEA team concluded that sufficient actions have been implemented to address this INSARR recommendation, but investigation of the need for installation of charcoal filtering system remains valid.

"**R12)** *The system for area classification and zoning from radiological protection should be revised in accordance with the IAEA safety standards No. SSR-3 and NS-G-4.6, considering the requirements for research reactors and taking into consideration the laboratories within the reactor premises."*

Implementation

Several laboratories within the HOR premises that handle radioactive materials are licensed by ANVS. While the zoning method for radiological protection recommended by the IAEA safety standards needs to be applied, the counterparts explained that RID also ought to comply with the national and Euratom regulations for such laboratories. Accordingly, implementing a common area classification that satisfies all requirements can be technically challenging. Nevertheless, the radiation protection expert and head of radiation protection unit were working towards establishing a new zoning method within the HOR premises, aiming to align with the IAEA safety standards and compliance with the applicable national regulations. By the time of the follow-up mission, however, no progress has yet been made. Nevertheless, it is worth noting that the RID staff are sufficiently informed on the radiological hazards present in different laboratories onsite and the needed training has been provided.

The IAEA team concluded that some actions have been implemented to address this INSARR recommendation. This recommendation remains valid and needs to be implemented.

3.2.10 Conduct of operations

"**S5)** *Safety awareness at the HOR during prolonged reactor shutdown may be further improved by:*

- *Applying reduced measures for radiation protection based on formalized procedures and ensuring the resumption of required measures after the HOR restart;*
- *Clearly showing signs in front of the (potentially) high dose areas."*

Implementation

As mentioned in Section 3.2.9, the additional RID human resource enabled the implementation of several actions to improve the radiological safety at HOR. In particular, the reduced measures for radiation protection during the prolonged reactor shutdown became irrelevant. Workplace contamination monitoring have been recovered at the exit for personnel leaving the reactor building.

During the facility walkthrough (also see Section 3.1), the IAEA team observed that a lead wall has been installed in front of the entire coolant system, for protecting against short lived activation products in the primary coolant, signs for indicating (potential) radiological areas and measures for preventing spread of (potential) leakage of contaminated are not implemented.

It has been concluded that the suggestion in this review area has been considered by RID with considerable actions having been taken.

"**R13)** *RID should consider improving the process of information flow between all levels of management so that the reactor manager would be in position to fully carry out his responsibility for safety. In particular, the reactor manager should ensure adequate checks and verification during the refuelling process and that the safety parameters of the newly assembled core configurations are verified in accordance with the OLCs."*

Implementation

As mentioned in Section 3.2.3, the newly developed job descriptions for the director of RID include the expected safety responsibilities for the reactor manager. In addition, a reactor management meeting has been conducted on a monthly basis with the attendance of the reactor manager (i.e. the director of RID) and the heads of HOR-O and HOR-B. The process of information flow for the HOR senior management has been improved accordingly. This in turn has also facilitated carrying out the responsibility for safety by the reactor manager.

During the discussion in the mission, the IAEA team clarified that the core management for HOR, which involves fissile materials handling, is one of the key topics in the reactor management meeting. The reactor manager discusses with the heads of HOR-O and HOR-B about the refuelling process, and the verification needs of safety parameters, in accordance with the OLCs of the new core configurations. The reactor manager, however, does not formally and directly authorize the HOR refuelling activities. As of the time of the follow-up mission, it is the IAEA team opinion that the reactor management meeting is mainly a means of informational communication rather than a step in a formal decision-making process.

The IAEA team concluded that actions have been implemented to address this recommendation but the part related to the functions of the reactor manager remains valid. The relevant issue is further discussed in Section 3.2.3 and addressed by a new recommendation. In this context, the **R13)** can be considered closed.

"**R14)** *Operating procedures and work instructions, including for radiological protection, should be revised to account for the modifications and to be consistent with the actual status of the facility."*

Implementation

Following the main INSARR mission, HOR was operated for a few months of time under the configuration of the in-pile section of the CNS not being installed. The operating procedures and work instructions were revised accordingly, in accordance with the INSARR

recommendations. Thereafter, HOR entered the second phase of the OYSTER project. The operating procedures and work instructions were revised again to reflect the actual status of the facility. Necessary training was provided to the operating personnel in December 2023 and the retraining activities are planned to be added in the RID management system. The IAEA team verified some of the training outputs by interviewing the on-duty HOR operator during the facility walkthrough. The IAEA team observed that the operating personnel possess good understanding on the OYSTER project updates in operating procedures and work instructions, and on the recently installed safety system setting on the CNS operation.

The IAEA team concluded that sufficient actions have been implemented to address this INSARR recommendation and that the relevant issue is closed.

3.2.11 Maintenance, periodic testing and inspection

"**R15)** *A work permit system should be established in accordance with the IAEA safety standards No. NS-G-4.2. This system should be used to improve record keeping in order to facilitate operating experience feedback and trending of maintenance, periodic testing, inspection, and ageing management."*

Implementation

A work permit system has been established, implemented for routine operation, and integrated into the HOR management system since 2021. The new work permit system followed a similar administrative approach to other existing approval mechanisms, for example, the one for radiation protection approvals owned by SBE or the one for fire protection permits own by V&B. The work permit system is applied to a list of activities identified by HOR-B, including those presenting operational health and safety risks (such as works in confined space or works at height) as well as radiological hazards.

Each work permit needs to be reviewed on safety aspects by ASD and the head of SBE, and authorized by the work permit coordinator, who is responsible for coordinating with the on-duty reactor operator. The work permits can last for several days, but there is a daily control for the accumulated dose and safety risks of involved equipment. The counterpart mentioned that they have a plan to use the record of work permits for trending analysis.

The IAEA team concluded that sufficient actions have been implemented to address this INSARR recommendation and that the relevant issue is closed.

"**R16)** *The results of the probabilistic safety assessment, including the risk importance factors of SSCs, should be utilized for further improvement of the maintenance, periodic testing and inspection programme as well as for ageing management."*

Implementation

The results of the probabilistic safety assessment have been used for improving the HOR maintenance programme by identifying the SSCs that have the largest contributions to the core damage frequency. For example, the preventive maintenance activities were amended to prioritize the systems that are relevant to the top 25 contributors to the core damage frequency. The counterpart further explained that the results of the probabilistic safety assessment indicated that the failure of the electromechanical relays used in the reactor safety system account for more than 50% contribution from the top 25 contributors to the core damage frequency. The replacement of these relay logics was thus taken place with priority to improve the safety and reliability of the facility.

The IAEA team concluded that sufficient actions have been implemented to address this INSARR recommendation and that the relevant issue is closed.

"**R17)** *Ageing management programme should be further improved by covering obsolescence of SSCs, identification of degradation mitigatory measures, and establishment of a process for managing spare parts for systems and components important to safety."*

Implementation

The HOR maintenance activities are managed using several working processes based on procedures and instructions as well as on databases and spreadsheets. These working processes together with a master list of registered assets are currently being integrated into a web-based asset management platform called Archibus. The registered assets are structured as per breakdown of SSCs in line with the examples provided in Annex II of IAEA Safety Standards Series No. SSG-10 (Rev. 1), consistent with the screening process in the ageing management programme. For example, degradation mechanisms and types of obsolescence of the registered items were specified in Archibus, including the information of spare parts for system and components important to safety. The counterpart indicated that the application of this web-based asset management platform is currently under testing and the full implementation is expected in summer 2025. The IAEA team noted that Archibus is being applied for the radioactive waste management (see Section 3.2.14). The IAEA team also noted that condition assessments as per the Dutch national standards (NEN 2767) were performed as a complement to the ongoing ageing management activities at HOR.

The IAEA team concluded that sufficient actions have been implemented to address this INSARR recommendation and that the relevant issue is closed.

3.2.12 Safety of utilization and experiments

"**R18)** *A formal process for safety categorisation of utilization and experiments should be established in accordance with the IAEA safety standards No. SSG-24. Utilization and experiments with major safety significance should be subjected to safety analysis, routes of approval, and procedures for design, quality, fabrication, and commissioning equivalent to those applied for the reactor itself."*

Implementation

Following the main INSARR mission, a formal process for safety categorisation of utilization and experiments has been established and implemented at RID. One output of the categorization process is to determine if any existing procedures for modification (namely, HOR2015-005P) or for new experimental facilities (namely, HOR1996-017P) can be used for the proposed utilization. If not, the proposed utilization is categorized as major safety significance and is subjected to review of the safety committee and review and assessment of ANVS. For example, the installation of the CNS falls into this category, and it is currently undergoing the commissioning tests similar to the process of commissioning a new reactor.

During the follow-up mission, the counterpart presented an illustrative table summarizing the method of safety categorization of utilization and experiments at RID. The IAEA team noted that the adopted approach is generally in line with the recommendations and the example of a categorization checklist provided in IAEA Safety Standards Series No. SSG-24 (Rev. 1), with respect to the safety considerations and approval routes. The main difference is that RID considered repetitive irradiations as "no effect on safety", instead of "minor effect on safety" recommended in SSG-24 (Rev. 1). The IAEA team explained that even though repetitive

experiments are bounded by the existing safety analysis and can be approved by the reactor manager, risk is not eliminated, e.g. equipment malfunctioning or radiation exposure are still relevant. Categorizing such experiments as "no effect on safety" does not reflect the necessary safety considerations and can be misleading. The counterparts agreed to the explanations and plan to revise the safety categorization method based on this explanation.

The IAEA team concluded that sufficient actions have been implemented to address this INSARR recommendation, and the relevant issue is closed.

3.2.13 Safety of modifications

"**R19)** *Criteria should be clearly defined, and documented, on what constitutes a routine replacement or a modification of SSCs important to safety. This should be supplemented by definition of the relevant safety requirements, including the need for safety analysis, routes for approval, and procedures for implementation."*

Implementation

Following the main INSARR mission, the counterpart analysed the existing management system for handling routine replacements and modifications of SSCs important to safety. Some updates have been implemented to better align the process with the recommendations provided by the IAEA Safety Standards Series No. SSG-24 (Rev. 1). For example, two additional web forms were created, one for modification (and utilization) applicant to conduct self-assessment on the safety implications and one for HOR-O to evaluate. These forms are also used to better distinguish between a routine replacement and an SSC modification. The record of web forms will be kept in a systematic manner and HOR-O will forward the applicable proposals to the safety committee for review. Instructions for the procedure modifications at RID were also be revised to improve clarity.

The IAEA team concluded that sufficient actions have been implemented to address this INSARR recommendation and that the relevant issue is closed.

3.2.14 Radioactive waste management

"**R20)** *RID should update the models and assumptions used for assessing the magnitude of the radionuclides released as gaseous effluents that cannot be measured by online methods, and submit the results to the safety committee and the ANVS for review and assessment."*

Implementation

Following the main INSARR mission, the counterpart conducted initial investigations with respect to the radionuclides released as gaseous effluents from HOR. The investigations concluded that the methods used in the assessment include some outdated assumptions and that no historical monitoring records were available for some radionuclides, such as ^{3}H and ^{14}C. Nevertheless, the counterpart confirmed that, for the radionuclides being monitored in the gaseous effluents, such as ^{41}Ar, and for the radioactivity measured for alpha, beta, and gamma particles, the established limits were never exceeded.

Additional efforts, led by the newly appointed ASD, are under preparation to improve the computational modelling and its assumptions. For example, it is planned to update the specifications of the ventilation and filtration systems and the information of on-site buildings and their recent modifications. It is also planned adopt the latest dose coefficients and involve additional radionuclides, such as ^{3}H, ^{14}C and potentially fissile elements, for the calculations of (committed) effective doses.

The counterpart mentioned that HOR is not the only contributor in the gaseous effluents from the site, which is covered by one single Nuclear Energy Act License (KEW license) granted by ANVS. Additional sources of release include, among others, the newly installed experimental facilities associated with CNS and the radionuclide laboratories of the department of Radiation, Science and Technology (RST), as well as the Holland Particle Therapy Centre (HPTC). It is planned to take all release sources on-site into account and prepare a comprehensive report, with updated radiological assessment of gaseous effluents, to support the KEW license amendment. Such report can be expected in the second half of 2024 and will be submitted to the safety committee for review and to ANVS for review and assessment.

The IAEA team concluded that sufficient actions have been implemented to address this INSARR recommendation and that the relevant issue is closed.

"**R21)** *RID should establish a procedure for keeping record of unused experimental equipment in the reactor pool and improve the process for declaring unneeded equipment as radioactive waste."*

Implementation

As mentioned in Section 3.2.11, a web-based asset management platform called Archibus is being integrated into the RID management system for asset registration, inventory management, maintenance scheduling, and ageing management. Archibus will also be used to enhance the traceability of experimental facilities, including the unused ones remained in the reactor pool, and the decision-making process when certain unneeded equipment ought to be declared as radioactive waste. By the time of the follow-up mission, a review assessment to determine the storage and disposal status of the HOR assets is planned on a yearly basis. The owner (or the responsible person) of any affected assets will be communicated with the determined actions. The assessment scope covers those unused experimental facilities and unneeded reactor components observed during the walkthrough of the main INSARR mission.

The IAEA team concluded that sufficient actions have been implemented to address this INSARR recommendation and that the relevant issue is closed.

3.2.15 Emergency planning

"**R22)** *RID should conduct an emergency drill before the planned return to normal operation for ensuring the awareness of the operating personnel, external response organizations and relevant authorities about the change in operational status after the prolonged shutdown of the reactor."*

Implementation

In 2023, RID updated the "disaster response plan" owned by the Safety Region Haaglanden (Veiligheidsregio Haaglanden) and the emergency response plan owned by SBE. Additionally, general emergency response trainings, such as first aid and firefighting, are regularly provided to the operating personnel. Six scenario trainings, analogy to emergency drills, were organized in 2023, including accident with personal injury, radiological contamination, and evacuation. External response organizations and relevant authorities were involved in these trainings.

The IAEA team concluded that sufficient actions have been implemented to address this INSARR recommendation and that the relevant issue is closed.

ANNEX I: AGENDA

Monday, 15 April 2024	
09:30	**Entry meeting: Review of mission objectives, expected results, and adoption of agenda** HOR: All ANVS: B. Keller (Director Competent Authority), R. Schippers, M. de Gier, P. Valkiers IAEA: All
10:00	**Presentation from HOR: Implementation status of the INSARR recommendations** IAEA: All HOR: All, presentation W. Koppers / C. Kaaijk ANVS: R. Schippers, M. de Gier
11:00	Coffee Break
11:30	**HOR Walkthrough** IAEA: All (Sun, Rao, and De Lorenzo) HOR: C. Kaaijk, H. Ardesch, K. van Kammen, M. de Meulmeester
12:30	Lunch Break
14:00	• **Operating organization and reactor management (2R)** • **Safety committee (1R)** IAEA: led by Sun HOR: W. Koppers, C. Kaaijk, H. Ardesch, A. Denkova, M. de Meulmeester ANVS: R. Schippers, M. de Gier
15:30	Coffee Break
16:00	• **Training and qualification (2R)** IAEA: led by De Lorenzo HOR: H. Ardesch, M van der Horst ANVS: R. Schippers, M. de Gier
17:00	• **Safety culture (1R&2S)** IAEA: led by Rao HOR: H. Ardesch, M. Vervoort, W. Koppers, M. Schouwenburg, M. de Meulmeester ANVS: R. Schippers, M. de Gier
18:00	Closure for Day 1 & IAEA Team Meeting (Hotel)
Tuesday, 16 April 2024	
09:00	• **Radiation protection (2R)** • **Radioactive waste management (2R)** IAEA: led by De Lorenzo HOR: K. van Kammen, M. Schouwenburg, M. de Meulmeester, J. Tober ANVS: R. Schippers
10:30	Coffee Break

11:00	• **Safety analysis and SAR (2R&1S)** IAEA: led by Sun HOR: N. van Wijk, G. Hassink, A. Winkelman, M. Schouwenburg, M. de Meulmeester ANVS: R. Schippers, J. Hartog
12:30	Lunch Break
14:00	• **Operational limits and conditions (2R)** IAEA: led by Sun HOR: H. Ardesch, N. van Wijk ANVS: R. Schippers
15:00	• **Regulatory supervision (1S)** IAEA: led by Rao HOR: C. Kaaijk, G. Hassink, M. Schouwenburg, M. de Meulmeester
15:30	Coffee Break
16:00	• **Emergency planning (1R)** IAEA: led by De Lorenzo HOR: M. Vervoort, M. Schouwenburg, M. de Meulmeester ANVS: R. Schippers
16:30	• **Conduct of operation (2R&1S)** IAEA: led by Rao HOR: H. Ardesch, C. Kaaijk, M. de Meulmeester, M. Schouwenburg ANVS: R. Schippers
17:30	Closure for Day 2 & IAEA Team Meeting (Hotel)
Wednesday, 17 April 2024	
09:00	• **Maintenance, periodic testing and inspection (3R)** IAEA: led by De Lorenzo HOR: H. Ardesch, A. van der Hurk, J. Tober ANVS: R. Schippers, A. Dijkman
10:30	Coffee Break
11:00	• **Utilization and experiment (1R)** • **Major modification (1R)** IAEA: led by Sun HOR: C. Kaaijk, N. van Wijk, A. Denkova, M. de Meulmeester , M. Schouwenburg ANVS: R. Schippers, A. Dijkman
12:30	Lunch Break
13:30	**Debriefing to ANVS** IAEA: All ANVS: Ronald Schipper and Philip Valkiers

14:00	**Development of the mission summary report** IAEA: All
15:30	Coffee Break
16:30	**Development of the mission summary report (continue)** IAEA: All
17:30	Closure for Day 3
19:30	ANVS Invited Social Dinner at *T Postkantoor, Delft*
Thursday, 18 April 2024	
09:00	**Finalization of the mission summary report** IAEA: All
10:30	Coffee Break
11:00	**Exit Meeting: Mission conclusions and recommendations** IAEA: All HOR: All ANVS: A. van Bolhuis (Chair of the Board), R. Schipper, P. Valkiers
12:00	Closing

ANNEX II: LIST OF PARTICIPANTS

RID Participants:

Wim Koppers, Director RID
Antonia Denkova; Chairman Reactor Safety Committee (RVC)
Camiel Kaaijk, Head of department HOR-Development
Henk Ardesch, Head of department HOR-Operations
Alex van den Hurk, Technical project coordinator HOR-operation
August Winkelman, Reactor Physics software specialist
Joeri Tober, Engineer HOR-Development
Gerwin Hassink, Engineer HOR-Development
Martijn de Meulmeester, Head of Radiation Protection Unit
Marcel Schouwenburg, General Radiation Protection Expert (RPE) TU Delft
Marcel Vervoort, Head of Safety and Security
Niels van Wijk, Engineer HOR-Development
Milan van der Horst, Staf member Training & Qualification HOR-Operation

ANVS Representatives:

Annemiek van Bolhuis, Chair of the Board
B. Keller, Director Competent Authority
Ronald Schipper, Senior Inspector, Regulatory Oversight and Enforcement
Anja Boxman-Dijkman, Officer Senior Inspector Human and Organisational Factors
Philip Valkiers, Advisor Administrative Affairs
Joppe Hartog, Licensing Nuclear Installations
Marjan de Gier, Coordinating specialist inspector

IAEA Team:

Mr Kaichao Sun, IAEA (Team Leader)
Mr Nestor de Lorenzo, Argentina
Mr Deshraju Rao, India