Operational
Safety Review
Team

IAEA OSART

REPORT

OF THE

OPERATIONAL SAFETY REVIEW TEAM

(OSART)

MISSION

TO THE

BORSSELE

NUCLEAR POWER PLANT

THE NETHERLANDS

23 JANUARY – 9 FEBRUARY 2023

AND

FOLLOW-UP MISSION

19 – 23 MAY 2025

DIVISION OF NUCLEAR INSTALLATION SAFETY
OPERATIONAL SAFETY REVIEW MISSION
IAEA-NSNI/OSART/216F/2025

PREAMBLE

This report presents the results of the IAEA Operational Safety Review Team (OSART) review of Borssele Nuclear Power Plant, the Netherlands. It includes recommendations and suggestions for improvements affecting operational safety for consideration by the responsible Netherlands authorities and identifies good practices for consideration by other nuclear power plants. Each recommendation, suggestion, and good practice is identified by a unique number to facilitate communication and tracking.

This report also includes the results of the IAEA's OSART follow-up visit which took place 27 months later. The inputs resulting from the follow-up mission can be found in the following chapters: last paragraph in the Executive Summary, self-assessment for the follow-up mission by the host organization and follow-up main conclusions by the IAEA follow-up team in the Introduction and Main Conclusions. In addition, the plant response/action and IAEA comments and Conclusion are under each Recommendation and Suggestion. The status of each issue is in the Summary of Status of Recommendations and Suggestions table, and the Follow-up team composition can be found at the end of the report.

The purpose of the follow-up visit was to determine the status of all proposals for improvement, to comment on the appropriateness of the actions taken and to make judgements on the degree of progress achieved

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

EXECUTIVE SUMMARY

This report describes the results of the OSART mission conducted for Borssele Nuclear Power Plant (NPP), the Netherlands from 23 January to 9 February 2023.

The purpose of an OSART mission is to review the operational safety performance of a nuclear power plant against the IAEA safety standards, make recommendations and suggestions for further improvement and identify good practices that can be shared with NPPs around the world.

This OSART mission reviewed 11 areas: Leadership and Management; Training and Qualification; Operations; Maintenance; Technical Support; Operating Experience Feedback; Radiation Protection; Chemistry; Emergency Preparedness & Response; Accident Management, and Use of PSA for Plant Operational Safety Improvements.

The mission was coordinated by an IAEA Team Leader and Deputy Team Leader, and the team was composed of experts from Czech Republic, France, Japan, Hungary, Slovakia, Spain, Sweden, Switzerland, United Arab Emirates, the United Kingdom and observers from Belgium and Mexico. The collective nuclear power experience of the team was 424 years.

The team identified 11 issues, three of them are recommendations, and eight of them are suggestions. Six good practices were also identified.

Several areas of good practice were noted:

- The plant has developed an easily applicable mechanism matrix to visualize ageing management activities in order to ensure effective ageing management of all systems structures and components in scope of its plant-level ageing management programme.
- The plant has developed a unique risk-informed application that categorizes the proposed areas of improvement identified in the Periodic Safety Review (PSR), according to deterministic and probabilistic risk benefits in order to concentrate efforts in areas most beneficial to safety.
- The plant implemented a passive Reactor Coolant Pump (RCP) seal isolation valve to reduce the risk of RCP seal failure and subsequent primary coolant loss in situations when the Emergency Core Cooling System (ECCS) is not available.

The most significant issues identified were:

- The plant should enhance the arrangements for the administration and control of operator aids to prevent the use of non-authorized operating documentation and other non-authorized material.
- The plant should strengthen the radiation protection practices for contamination control, dose planning and the control of radioactive sources to ensure that the requirements of the radiation protection programme are fully met.
- The plant should consider enhancing its worker implementation of chemical control practices to ensure appropriate identification, labelling, storage and safe handling with chemicals as well as accurate results of chemical analyses.

Borssele NPP management expressed a determination to address the areas identified for improvement and indicated a willingness to accept a follow up visit in about 18 to 20 months.

At the time of the follow-up mission in May 2025, 27 months after the OSART mission, 73% of issues had been resolved, 27% were satisfactory progress to date and 0% were insufficient progress.

CONTENT

INTRODUCTION AND MAIN CONCLUSIONS

INTRODUCTION

At the request of the government of the Netherlands, an IAEA Operational Safety Review Team (OSART) of international experts visited Borssele Nuclear Power Plant from 23 January to 9 February 2023. The purpose of the mission was to review operating practices in the areas of Leadership and Management for Safety, Training and Qualification, Operations, Maintenance, Technical Support, Operating Experience Feedback, Radiation Protection, Chemistry, Radiation Protection, Chemistry, Emergency Preparedness and Response, Accident Management and Use of PSA for Plant Operational Safety Improvements. In addition, an exchange of technical experience and knowledge took place between the experts and their plant counterparts on how the common goal of excellence in operational safety could be further pursued.

The Borssele NPP is located in the Sloe area in the municipality of Borssele, on the estuary of the Schelde River. The plant is owned and operated by the 'Elektriciteits Produktiemaatschappij Zuid-Nederland' (Electricity Production Company South-Netherlands) (EPZ). With its one 482 MWe pressurized water reactor, every year Borssele accounts for 3.1% of the country's electricity production. In 2021, the plant generated 3.6 TWh. Borssele nuclear reactor was commissioned in 1973. The Borssele NPP employs approximately 400 persons: 350 employees and 50 employees from permanent subcontractors.

The Borssele OSART mission was the 216th in the programme, which began in 1982. The team was composed of experts from Czech Republic, France, Japan, Hungary, Slovakia, Spain, Sweden, Switzerland, United Arab Emirates, the United Kingdom and two IAEA staff members and observers from Belgium and Mexico. The collective nuclear power experience of the team was 424 years.

Before visiting the plant, the team studied information provided by the IAEA and the Borssele plant to familiarize themselves with the plant's main features and operating performance, staff organization and responsibilities, and important programmes and procedures. During the mission, the team reviewed many of the plant's programmes and procedures in depth, examined indicators of the plant's performance, observed work in progress, and held in-depth discussions with plant personnel.

Throughout the review, the exchange of information between the OSART experts and plant personnel was very open, professional and productive. Emphasis was placed on assessing the effectiveness of operational safety rather than simply the content of programmes. The conclusions of the OSART team were based on the plant's performance compared with the IAEA Safety Standards.

The following report is produced to summarize the findings in the review scope, according to the OSART Guidelines document. The text reflects only those areas where the team considers that a Recommendation, a Suggestion, an Encouragement, a Good Practice or a Good Performance is appropriate. In all other areas of the review scope, where the review did not reveal further safety conclusions at the time of the review, no text is included. This is reflected in the report by the omission of some paragraph numbers where no text is required.

MAIN CONCLUSIONS

The OSART team concluded that the managers of the Borssele NPP are committed to improving the operational safety and reliability of their plant. The team found areas of good practice, including the following:

- The plant has developed an easily applicable mechanism matrix to visualize ageing management activities in order to ensure effective ageing management of all systems structures and components in scope of its plant level ageing management programme.
- The plant has developed a unique risk-informed application that categorizes the proposed areas of improvement, identified in the Periodic Safety Review (PSR), according to deterministic and probabilistic risk benefits in order to concentrate efforts in areas most beneficial to safety.
- The plant implemented a passive Reactor Coolant Pump (RCP) seals isolation valve to reduce the risk of RCP seal failure and subsequent primary coolant loss in situations when the Emergency Core Cooling System (ECCS) is not available.

A number of proposals for improvements in operational safety were offered by the team. The most significant proposals include the following:

- The plant should enhance the arrangements for the administration and control of operator aids to prevent the use of non-authorized operating documentation and other non-authorized material.
- The plant should strengthen the radiation protection practices for contamination control, dose planning and the control of radioactive sources to ensure that the requirements of the radiation protection programme are fully met.
- The plant should consider enhancing its worker implementation of chemical control practices to ensure appropriate identification, labelling, storage and safe handling with chemicals as well as accurate results of chemical analyses.

Borssele NPP management expressed a determination to address the areas identified for improvement and indicated a willingness to accept a follow up visit in about 18 to 20 months.

BORSSELE NPP SELF ASSESMENT FOR THE FOLLOW-UP MISSION

From 23 January – 9 February 2023, an OSART team reviewed the operating practices and corporate functions at the NPP Borssele at the request of the Dutch regulator ANVS.

The review resulted in five good practices, three recommendations and eight suggestions. EPZ is very grateful to the OSART team. These results help EPZ in its ambition to achieve excellence in safety and reliability.

EPZ has the ambition to be a global leader in safety and reliability. Therefore, EPZ started in 2021 a program Road to Excellence, in Dutch: ‘Op Weg Naar Excellence’ (OWNE). This program consists of a Roadmap with clear goals for the coming three years, a performance monitoring system based on WANO Action for Excellence Enhanced Performance Monitoring, and a set of strategic improvement projects addressing the main gaps to excellence.

The first step after the OSART mission in 2023 was to determine if and how the OSART issues could be incorporated in the existing improvement program ‘Road to Excellence’ and for which issues specific improvement projects should be defined. An important lesson from the OSART mission was that our approach to addressing the issues should be based on engagement of the staff involved on all levels of the organization. Therefore, the action plan for the LMS 1.1(1) issue was seen as the main driver for further improvement and is given high priority. To reflect this priority the company CEO was appointed as responsible sponsor for this project.

The results of the analysis were the following:

- LMS1.1(1) The plant leadership should consider enhancing the ways in which it engages workers in initiatives to achieve excellence in operational performance.

  This was seen as a companywide important driver for other existing gaps to excellence. Therefore, a strategic improvement program (OWNE.10) was defined and priority was given to actions to improve in this area.

- TQ 2.2(1) The plant should consider enhancing the monitoring and evaluation of training delivery to ensure that plant personnel attend the required training related to their duties.

  This suggestion could be addressed in the Training and Qualification process and therefore a specific action plan was defined.

- OPS 3.3(1) The plant should enhance the arrangements for the administration and control of operator aids to prevent the use of non-authorized operating documentation and other non-authorized material.

  A specific action plan was defined, led by the OPS department. The lessons learned from issue LMS1.1(1) and the approach of the OWNE.10 Improvement Plan have explicitly been applied to engage workers from all levels in solving this issue.

- OPS 3.4(1) The plant should consider enhancing its arrangements for the management of leaks in order to ensure the correct identification, management and timely resolution of leaks.

  This suggestion could be addressed in the OPS process and therefore a specific action plan was defined within the operations department.

- MA 4.2(1) The plant should consider enhancing its corrosion protection and inspection programmes to ensure timely identification, monitoring and correcting of safety and non-safety related SSC, whose failure could jeopardize the safe operation of the plant due to corrosion effects.

  This suggestion related strongly to the existing initiative to improve Equipment Reliability. Therefore, this issue is fully integrated in the Strategic OWNE.6 Equipment Reliability Improvement Program, and specific actions to address this issue have been added.

- TS 5.1(1) The plant should consider strengthening its programmes for System Health Monitoring and Obsolescence to ensure that they are robust and prioritized to ensure that the potential risk of degradation of the plant systems and components is minimized.

  This suggestion related strongly to the existing initiative to improve Equipment Reliability. Therefore, this issue is fully integrated in the Strategic OWNE.6 Equipment Reliability Improvement Program.

- RP 7.3(1) The plant should strengthen the radiation protection practices for contamination control, dose planning and the control of radioactive sources to ensure that the requirements of the radiation protection programme are fully met.
- RP 7.3(2) The plant should enhance the arrangements for resolving radiological field deficiencies in order to ensure that the deficiencies are addressed in a timely manner.

  These two recommendations in RP confirmed some other signs that a gap to excellence in RP existed. On top of that a raise of standards in Radiation Protection and Radiation Safety can only be achieved with commitment of the complete organization. Therefore, a Strategic improvement program (OWNE.11) was added, in order to address and close the gap to excellence in RP, including the OSART recommendations.
  The lessons learned from issue LMS1.1(1) and the approach of the OWNE.10 Improvement plan have explicitly been applied to engage workers from all levels in solving this issue

- CH 8.5(1) The plant should consider enhancing its worker implementation of chemical control practices to ensure appropriate identification, labelling, storage and safe handling with chemicals as well as accurate results of chemical analyses.

  This suggestion was seen as mostly specific for the Chemistry Process. Therefore, a specific action plan was defined, led by the chemistry department

- EPR 9.2(1) The plant should consider improving the plant provisions for protective actions in case of an emergency to ensure timely and efficient emergency response.
- EPR 9.3(1) The plant should consider improving the preparedness of its emergency facilities, equipment, and documentation to ensure effectiveness of the emergency response organization.

  For the suggestions in EPR specific actions were defined and taken by the EP process owner. In parallel a more comprehensive improvement plan to address the organizational aspects of EPR is under construction.

After defining the improvement approach action plans have been made. Every action plan had a senior manager as sponsor and a clear responsible owner for the plan. The action plans have been challenged in meetings with the Site Management Team and the Internal Safety Review Committee. The progress and effectiveness were reported and discussed in monthly OSART FU meetings with the Issue Owners and the sponsor managers present.

For all issues defined by the 2023 OSART mission, clear actions have been taken and significant improvement is visible. More details describing the actions taken and the results achieved can be found in the plant response paragraphs for each issue.

Borssele NPP is committed to further improvement in these areas through the process of continuous improvement.

BORSSELE NPP OSART FOLLOW-UP MAIN CONCLUSION

An IAEA OSART Follow-up Team visited Borssele NPP from 19-23 May 2025. There was clear evidence that the plant had gained significant benefit from the OSART process. The IAEA Safety Standards and benchmarking activities with other NPPs were used by the NPP during the preparation and implementation of their corrective action plans.

The plant thoroughly analysed the OSART recommendations and suggestions and developed appropriate corrective action plans. In some instances, these corrective actions covered a broader scope than the original OSART recommendations and suggestions. The willingness and motivation of plant management to use benchmarking, consider new ideas and implement a comprehensive safety improvement programme was evident and is a clear indicator of the potential for further improvement of the operational safety of the Borssele NPP.

The plant had fully resolved issues regarding:

- effective engagement of the plant workers in initiatives to achieve excellence in operational performance,
- monitoring and evaluation of training delivery to ensure that plant personnel attend the required training related to their duties,
- administration and control of operator aids,
- management of leaks to ensure the correct identification, management and timely resolution of leaks,
- management of corrosion protection and inspection programmes
- arrangements for addressing improper behaviours and resolving radiological field deficiencies
- arrangements for improving chemical control practices and accuracy of chemical analyses results
- arrangement for improving the preparedness of the plant emergency facilities, equipment and documentation

Issues where satisfactory progress towards resolution has been made but further work is necessary are as follows:

- The plant action plan has enabled a good platform to succeed in solving the issue on equipment reliability and obsolescence. At this stage the results demonstrate the plant has not yet achieved its KPI targets related to equipment reliability and is expected to reach its goals only beyond 2025. Additionally, several operating events related to equipment reliability led to plant shutdowns. Management of obsolescence is at a stage where the project is to be delivered in the line organization and still several open articles do exist that have to be handled to get a more stable situation. In summary, the plant has accelerated the activities with equipment reliability and obsolescence, however, some actions to meet the desired robustness still need to be completed.

- The plant had strengthened the radiation protection practices for dose planning and the control of radioactive sources. However, the plant continued to have events associated with ineffective contamination control measures, which had resulted in two cases where contamination was detected outside of the RCA. Additional plant efforts and work were required to reinforce and enhance further contamination control measures.
- In line with the action plan new measurements have been installed in the ECC, and a physical inspection has confirmed that the required quantities of iodine tablets, with valid expiry dates, are stored in the designated locations. The functions of the key positions of the ERO recall system have been adjusted to account for potential deterioration of conditions at the plant. However, further work on the overall organizational and procedural strategy for implementing protective actions is still planned. Revisions to some procedures, documents and organizational arrangements remain incomplete. The plant is also in the process of developing a more systematic approach for the storage and distribution of iodine tablets in an effective manner and how to improve the procedures for the protection of radiation technicians at the dedicated nuclear muster point. The provision of security workplace safety equipment such as protective suits, coveralls and gloves had not yet been completed. Continued efforts are necessary to complete these improvements.

No issue was assessed as having made insufficient progress to date.

In February 2023, the original OSART team developed three recommendations and eight suggestions to further improve operational safety of the plant. At the time of the follow-up mission, some 27 months after the OSART mission, 73% of issues had been resolved, and 27% had made satisfactory progress.

The team received full cooperation from the Borssele NPP management and staff and was impressed with the actions taken to analyse and resolve the findings of the original mission. The team was able to verify all information considered relevant to its review. In addition, the team concluded that the managers and staff were very open and frank in their discussions on all issues. This open discussion made a significant contribution to the success of the review and the quality of the report.

1. LEADERSHIP AND MANAGEMENT FOR SAFETY

1.1. LEADERSHIP FOR SAFETY

The plant management team has established a vision and strategy through which performance at the plant was improving. Plant management works in a facilitative manner with the workforce to create and implement strategies and improvement initiatives. The management team had also developed plant-specific leadership and nuclear professional development projects which have been implemented. The nuclear professional programme engaged the workers in a proactive manner to obtain their perspective and inputs as to what it means to be a nuclear professional. The team supported the plant to continue building upon these programmes.

A review of events, near-misses, and field observations identified some weaknesses in worker behaviors related to industrial safety, leak identification and reporting for corrective maintenance and effective use of human performance tools. While leader values and management programmes were established and clear in these areas, compliance with these programmes and values was not consistent and systematic. Worker understanding of and compliance in these areas is important to ensure plant and personnel safety. The OSART team observed that while the plant had performance indicators in key areas, these had not been implemented systematically at the worker level which would help the workers understand their gaps and opportunities to achieve industry excellence in operational performance. The team made a suggestion in this area.

1.2. MANAGEMENT SYSTEM

Plant management has integrated their business planning and management system in a manner that drives continuous improvement. Business planning and the Integrated Management System are aligned with the same structure in context, results, elements, key performance indicators, objectives and improvement programmes. The Business Plan covers a period of three years and is updated annually. The overall benefits gained by the plant have been significant and the team recognized this as a good performance.

During the OSART mission, it was noted that the plant had an effective working relationship with the regulator. Specifically, the senior management proactively engaged regulatory counterparts, sought their insights, and accepted their feedback in a positive way. Information and analysis provided to the regulator by the plant technical staff was typically thorough and comprehensive. The team supported the plant to maintain their focus on this relationship for future decisions the company will make.

Communications, both internal and external, demonstrate the leadership commitment to transparency with all stakeholders. The plant had established regular communications forums with all plant personnel in a variety of settings to cascade and listen regarding decisions affecting the plant and people. The team observed an innovative method of communicating improvement projects with stakeholders that depicted a cross functional view of the plant with all of the upcoming improvements for the next three years. The team supported the plant to continue innovative methods for stakeholder communications.

1.3. CULTURE FOR SAFETY

The team did not undertake a detailed safety culture assessment at the plant. However, the overall experience of the team was utilized to capture safety culture attributes, behaviours and practices which help to shape and define the safety culture at the plant. With respect to observed strengths, the team noted that the strongest characteristic was that safety is a clearly recognised value for the plant driven with a strong desire to learn from others to improve safety performance and understand the factors affecting performance not meeting industry excellence.

The team also noted that an open working relationship existed between the plant and the regulatory body regarding the sharing of information and working together on the quality and comprehensiveness of the licensing requirements.

However, the team noted that some attributes could be strengthened to improve the safety culture characteristic: leadership for safety is clear. The team observed that deviations from established standards and expectations contributed to operational events, human performance errors, industrial safety deviations, and radiation work practices deviations. The leadership and safety culture initiatives have not been fully effective in communicating, checking understanding, and reinforcing the individual’s understanding and responsibility for the impact of their actions on safety. This indicated that some shortfalls still exist in the following safety culture characteristic: leadership for safety is clear.

DETAILED LEADERSHIP AND MANAGEMENT FOR SAFETY FINDINGS

1.1. LEADERSHIP FOR SAFETY

1.1(1) Issue: Plant leaders are not always effective in engaging workers in initiatives to achieve excellence in operational performance.

During the review the team noted the following:

- Of the 258 actions from the plant strategic improvement initiatives (OWNE) entered in the corrective action programme, 250 were owned by Team Leaders, Managers or Process Owners.

- Human performance events, while improving, had not achieved industry standards of excellence. Worker participation in the development of corrective actions and sharing of lessons learned was not consistently achieved.

- While at the plant, the OSART Team observed instances of workers not adhering to the plant standards. Examples include:

  - workers did not always use eye protection and gloves when performing activities in the field;
  - fire doors were not always closed by plant personnel, as required;
  - workers did not pay sufficient attention to leak identification and reporting for corrective maintenance;
  - workers demonstrated in some cases incorrect radiation protection work practices specifically in the removal of potential contaminated protective clothing at radiological barriers.

  These gaps are contrary to the plant's vision for working safely and demonstrating high standards as nuclear professionals.

- The plant Key Performance Indicators (KPIs) relative to industry excellence were not consistently utilized at all levels of the organization to clearly demonstrate where performance was in relationship to improving worker performance or in comparison with industry norms. The plant displayed its high-level performance metrics in strategic areas of the plant but individual organizational KPIs were not displayed or routinely discussed with all levels of the organization for worker understanding of their performance relative to industry excellence.

Failure to fully create an environment where the workforce understands and owns their performance against industry excellence could cause complacency and sustainability challenges and lead to deteriorating plant performance.

Suggestion: The plant leadership should consider enhancing the ways in which it engages workers in initiatives to achieve excellence in operational performance.

IAEA Bases:

GS-G-3.5

2.26 … Ideally, all individuals should be involved in proactively contributing ideas for improvements. More sustainable approaches would involve encouraging individuals to work in teams and continually seek improvements by identifying and prioritizing actions to enhance safety in their own work areas. To facilitate this, individuals should be given the opportunity to compare their way of working with that of others, so that they are aware of what constitutes excellence in their area of work.

GS-G-3.1

6.12 … Individuals and management (other than senior management) at all levels in the organization should periodically compare present performance with management expectations, worldwide industry standards of excellence and regulatory requirements to identify areas needing improvement.

Plant Response/Action:
Based on the outcome of the OSART mission, the plant redefined its roadmap and improvement activities to focus on establishing a culture of continuous improvement, based on the values of WANO staying on top.

To support this change a strategic project OWNE 10: blijven streven naar excellence (‘striving for excellence’) was established with a project leader from the site management team and a monthly steering group consisting of – among others – the CEO and the plant manager.

An extensive cause analysis was performed, taking into account different internal and external evaluations. An action plan was developed which was challenged by representatives of the shop floor, the reactor safety board and the management team. Actions were tracked through the CAP and the monthly steering group.

The actions focused first on addressing the necessary leadership improvements identified in LMS 1.1(1) by OSART in 2023: Plant leaders are not always effective in engaging workers in initiatives to achieve excellence in operational performance.

Cause:
Five drivers for the necessary change for a culture of continuous improvement were established.

- Establish the necessary leadership behaviors, including defining what effective engagement by leaders should look like;
- Make industry excellence better known in the organization;
- Engage workers in improvement activities;
- Promote self-awareness and self-correction throughout the organization;
- Use positive reinforcement.

Actions Performed:
A summary of actions performed:

- Effective engagement by leaders was the topic of several leadership development activities
    - For example, a session with the site management team to define effective engagement and how the site management team could facilitate the change.
      This outcome was challenged by the sounding board and young professionals.

    - Several sessions with all leaders during the quarterly leadership days.

  Engagement is now fully integrated in the leadership program.
- Processes and improvement activities were redefined or restructured to better support the engagement of workers in achieving excellence in operational performance
    - The strategic improvement projects (OWNE) such as OWNE 2: Operator fundamentals, OWNE 3: Excellent standards within maintenance and OWNE 11: Radiation protections were fully developed with the workers.
    - Part of the recruitment process of new managers is writing an essay on their vision of how to apply the values of staying on top.
    - An onboarding program was set up with the objective to quickly engage new staff in contributing to excellent performance
    - Workers are more engaged in the CAP and annual plan processes.
    - The agendas of the management teams were modified to focus more on worker initiatives
- Because some teams were understaffed, the plant decided to attract additional staff to support these teams to work on the necessary improvements.
- Workers were asked to lead concrete improvement activities such as defining and implementing clearer standards for housekeeping and storage, managing operator aids and defining WELL sheets.
- Communication strategy changed to highlight positive contributions of workers
- The training programme of nuclear professionals was modified to focus more on self-awareness and self-correction.
- A companywide programme called 'Lets fix this together' was launched for all staff in which groups of workers from different departments come together and aided by a facilitator, choose an improvement that they want to realize in the coming period. In these collaborations, managers act as sponsors.

Results and Effectiveness:

- Industry excellence is better understood.
- Correcting deviations from standards on a worker-to-worker level has improved.
- The number of reported low level events has increased. And the number of high-risk events has decreased.
- The number of good practices reported has increased.
- The percentage of CAP items on worker level has increased.
- Trust and employee satisfaction (as measured by survey) have improved.

New actions have been defined to continue the change towards a culture of continuous improvement.

IAEA comments:

The plant has carefully evaluated this suggestion and based on cause analysis determined the following five change drivers necessary for establishing a culture of continuous improvement as defined in the strategic vision of the plant:

- to establish the necessary leadership behaviors, including defining what effective engagement by leaders should look like
- to make industry excellence better known in the organization
- to engage workers in improvement activities
- to promote self-awareness and self-correction throughout the organization
- to use positive reinforcement

To address the above the plant has established a ‘Strategic improvement project’ involving a project leader from site management team, diverse project team members and the Chief Executive Officer (CEO) as a sponsor of the project. The plant performed a driver’s analysis and established an action plan after multiple challenge meetings. The action plan is tracked through the plant Corrective Action Programme (CAP) and reviewed monthly by a steering group.

Many activities were conducted at the plant in frame of this ‘Strategic improvement project’ including ‘Session on engagement with the site management team’, several ‘Leadership days’, ‘Engaging workers in concrete improvement initiatives’, ‘Several activities on making excellence better known’ and a modified communication strategy for ‘Positive reinforcement’.

As a result of these efforts the plant may declare that many actions to enhance worker engagement were executed, the industry excellence, due to extensive promotion, is now better understood and known by the plant staff, standards adherence has improved and reporting of deficiencies at lower levels increased.

The plant has defined new actions to continue the way towards a culture of continuous improvement.

During the follow-up review the team observed that a significant part of the activities within the plant’s action plans, developed in response to the OSART recommendation and suggestion has been initiated and performed by the plant personnel that in turn supports the plant management’s efforts in engaging the personnel in continuous improvement and in striving for operational excellence.

Conclusion: Issue resolved

2. TRAINING AND QUALIFICATIONS

2.2. QUALIFICATION AND TRAINING OF PERSONNEL

The plant had developed a new Work Practice Simulator (WPS) in 2017. The WPS had a special connection for mobile equipment (FLEX) and was used for training on the connection of the mobile emergency diesel in case of a plant Black Out. In addition, the WPS was also equipped with a replica of the reactor control level safety system to help the electrical maintenance workers and shift personnel investigate alarms and diagnose component failures on the control panels and in the cabinets. The team recognized this as good performance.

The plant monitoring and evaluation of training delivery did not always ensure that plant personnel attend the required training related to their duties. There were examples of mandatory and refresher training which had not been completed within the maintenance and emergency preparedness organisations. The team made a suggestion in this area.

The plant training department dashboard did not have a specific Key Performance Indicator (KPI) for monitoring training effectiveness of the worker’s performance in the field and consequently no KPI on training effectiveness was reported to the management team. The team encouraged the plant to develop metrics which show training effectiveness and report these to senior management.

DETAILED TRAINING AND QUALIFICATION FINDINGS

2.2. QUALIFICATION AND TRAINING OF PERSONNEL

2.2(1) Issue: The plant monitoring and evaluation of training delivery does not always ensure that plant personnel attend the required training related to their duties.

During the review the team noted:

- To date, approximately fifty personnel had not completed all the required emergency training. For example, 28 field operators did not have the refresher training in emergency procedures. Another example, four of the site emergency directors did not attend the required yearly refresher course for operations since January 2022.
- To date, there is still 3% of the mandatory training that were not completed by staff on time. For example: 25 maintenance staff did not have all the training competences required up to date; 11 maintenance staff did not have the refresher training in the simulator; eight maintenance staff did not have the refresher training in the reactor physics basic level; seven maintenance staff did not have the refresher training in work at heights; two maintenance staff did not have the refresher training in rigging and lifting.
- Even though the mandatory training key performance indicators (KPIs) met the expectation (at least 95%), 4% of the mandatory training required for the staff was not attended by some plant employees in 2022.
- Even though the on-the-job training (OJT) KPI met the expectation (at least 90%), 8% of the OJT desired was not attended by some plant employees in 2022.
- Even though the emergency preparedness KPI met the expectation (at least 90%), 9% of the mandatory competences required were not attended by the staff in 2022.
- The plant did not track the number of all personnel who were supposed to attend the training but did not attend. The KPI used to measure this only consider the number of personnel that did not attend the training without giving the required 24 hours' notice.
- The plant self-identified that currently the fire detection alarms were not simulated in the control room simulator.

Without ensuring that all personnel have completed the required training, personnel may not be able to fulfil all their duties effectively.

Suggestion: The plant should consider enhancing the monitoring and evaluation of training delivery to ensure that plant personnel attend the required training related to their duties.

IAEA Bases:

SSR-2/2 (Rev. 1)

Requirement 7: Qualification and training of personnel

The operating organization shall ensure that all activities that may affect safety are performed by suitably qualified and competent persons.

4.18. The management of the operating organization shall be responsible for the qualification and the competence of plant staff.

4.19. A suitable training programme shall be established and maintained for the training of personnel before their assignment to safety related duties. The training programme shall include provision for periodic confirmation of the competence of personnel and for refresher training on a regular basis.

4.20. Performance based programmes for initial and continuing training shall be developed and put in place for each major group of personnel (including, if necessary, external support organizations, including contractors).

4.21. The training programmes shall be assessed and improved by means of periodic review.

4.23. All training positions shall be held by adequately qualified and experienced persons, who provide the requisite technical knowledge and skills and have credibility with the trainees.

Requirement 18: Emergency preparedness

5.5. A training programme for emergencies shall be established and implemented to ensure that plant staff and, as required, staff from other participating organizations possess the essential knowledge, skills and attitudes required for the accomplishment of non-routine tasks under stressful emergency conditions.

SSG-75

3.1. Requirement 7 of SSR-2/2 (Rev. 1) [1] states that “The operating organization shall ensure that all activities that may affect safety are performed by suitably qualified and competent persons.”

4.15 (e) Evaluation. In this phase, all aspects of the training programmes should be evaluated on the basis of data collected in each of the other phases…

4.45. … The documentation should be used to assist managers in monitoring the effectiveness of the training programme (see para. 4.23 of GSR Part 2 [3]), as well as in an annual management review of the competence of personnel.

4.49. The training entity should report periodically to appropriate levels of management on the status and effectiveness of training activities.

5.42. Paragraph 4.21 of SSR-2/2 (Rev. 1) [1] states that “The training programmes shall be assessed and improved by means of periodic review.” The review should cover the adequacy and effectiveness of training with respect to the actual performance of personnel in their jobs.

5.43 The review of training programmes should be undertaken by persons other than those directly responsible for the training. Plant managers should be directly involved in the evaluation of training programmes. Close cooperation should be maintained in the training evaluation process between plant managers, individual departments and the training entity.

Plant Response/Action:

The general qualification policy is focused on reducing gross risk to an acceptable net risk. For control room staff job qualification is required to become a licensed operator. For jobs in other departments task qualification is the standard. This means that a very large number (7524) of qualifications have to be checked if they relate to the right jobs.

The qualification policy states that line managers are responsible for deployment of qualified staff and the training department facilitates this process. However, this general qualification policy is not established at the highest level of the organization but in a manual of the training department. Partly because of that the qualification policy appeared to be not commonly known by all staff and not executed consistently.

All mandatory training is collected in a central database. A cross section can be made for all mandatory training per worker or all mandatory training by type of training. This report is used by the training coordinators to plan the required training. Managers have the opportunity to consult the same report. There is no report available with the focus on the number of qualified staff.

The main KPI on training delivery is focused on all mandatory training. The operational goal is ‘98% of all mandatory training is delivered’ (strategic goal is 100%). This is assumed to be a good performance. About 2% of all training is not delivered. This seems to be a very low percentage. However, it is 2% of a very large amount of all qualifications (7524). So, it is possible that about 150 qualifications are not fulfilled. Some of these can be related to high risk work.

Summary of the underlying causes:

- The qualification policy was mainly based on task qualification and not established at the highest level of the organization.
- The central training database had no cross section for job qualification.
- No KPI was available on job qualification.

Actions Performed:

- The modified qualification policy has been established at the highest level of the organization.
- Job qualification has been made mandatory for all operational jobs with a high risk. Task qualification is related to very high risk on nuclear- and industrial safety.
- A new cross section with all job qualifications has been added to the central database, this customized report is available for all managers.
- A new KPI based on the number of qualified workers is available for all managers and has been added to the annual business plan.
- The modified qualification policy, customized KPI’s and a new report have been communicated to all involved managers.

Results and Effectiveness:

A modified qualification policy resulting in managers having better insight into the availability of qualified staff. Managers are more involved to the qualification process what results in less deficiencies.

IAEA comments:

The plant has thoroughly analysed this suggestion and developed and executed an action plan to address the issue.

The root cause analysis showed that the previous qualification policy was mainly based on task qualification, was unclear and was not fully established at the highest level of the organization. The central training database did not have any cross-section activities for job qualifications. Relevant KPIs were not available for job qualifications with limited oversight due to of a very high number of qualifications and lack of managers involvement in the process. The analysis of the Issue identified that for large number of qualifications control and monitor was complicated implying that some qualifications could be easily overlooked.

The action plan consisted of four main areas. Firstly, to establish a commitment at the top of the organization with a modified qualification policy, secondly, focus more on job qualification instead of task qualification to create better oversight, thirdly, modify and develop KPIs related to job qualification and fourthly; emphasize managerial ownership.

Implementation of actions have given the plant a better overview of required training and facilitated the managers and training department to follow up on performed and not completed training. During the implementation activities the plant has extended the proof of qualified employees to involve other categories such as chemists, radiation protection technicians and trainers.

The manager’s role and the extended focus on this area have changed through the modified qualification policy towards more understanding and involvement resulting in less deficiencies and more responsibility.

Current KPIs demonstrate the following status: mandatory training required, 99% (operational target 98%), KPI: on-the-job training 96% (operational target 92%), KPI: emergency preparedness 97% (operational target 95%).

When measuring training attendance, the relevant KPI from WANO is used and the result is 98.5% and the KPI shows a steady positive development since 2023.

Conclusion: Issue resolved.

3. OPERATIONS

3.2. OPERATIONS EQUIPMENT

The plant had introduced Bluetooth hearing protection to aid communication in high noise areas. This initiative was introduced at the start of the COVID-19 pandemic in order to ensure clear and concise communication whilst maintaining social distance protocols. Due to the adaptability of the new Bluetooth hearing protection, it has been seamlessly integrated into the communication system in the plant and can also be used for conference calls, as well as one-to-one calls. This has proven particularly beneficial during plant testing with multiple individuals working at different locations. The team identified this initiative as good practice.

3.3. OPERATING RULES AND PROCEDURES

The team noted several unauthorized operator aids around the plant. A review of plant policy and procedure revealed that, although there was a procedure for the use of operator aids, the procedure had not been fully implemented. This has led to inconsistencies in the format and quality of information on the operator aids. The team made a recommendation in this area.

3.4. CONDUCT OF OPERATIONS

The plant had procedures in place that provided the requirements for the identification, management and resolution of leaks. However, these requirements were not consistently applied. In addition, the plant procedures did not stipulate the required standard for the implementation of leak management on plant in service. It did not detail the requirements for the management of leak pads, nor did it detail the expected behaviours of the individuals managing the leak when the leak was on in-service plant equipment. The team made a suggestion in this area.

The plant had implemented a ‘Man Down’ system to facilitate a quick response to individuals in an emergency. The purpose of the system was to notify the Control Room when individuals out on plant were in distress or potential difficulty. The signal was activated either manually, or automatically when the phone was at a tilt angle of 60 degrees for greater than 20 seconds. The Main Control Room immediately receives an alarm and information showing the identity and the exact location of the individual. This enabled a rapid response in case of an emergency. The team recognized this as good practice.

3.6. FIRE PREVENTION AND PROTECTION PROGRAMME

All rooms on the plant have been assessed for fire loading and baselined accordingly. During the preparation phase for planned work, all tasks were assessed against the fire loading criteria for that area and if the fire loading would increase as a result of the task, appropriate mitigating measures were documented in a fire permit and the measures identified implemented prior to the commencement of the task. The team recognized this as a good performance.

DETAILED OPERATIONS FINDINGS

3.2. OPERATIONS EQUIPMENT

3.2(a) Good Practice: The plant has implemented a ‘Man Down’ system to facilitate a quick response to individuals in an emergency.

Purpose

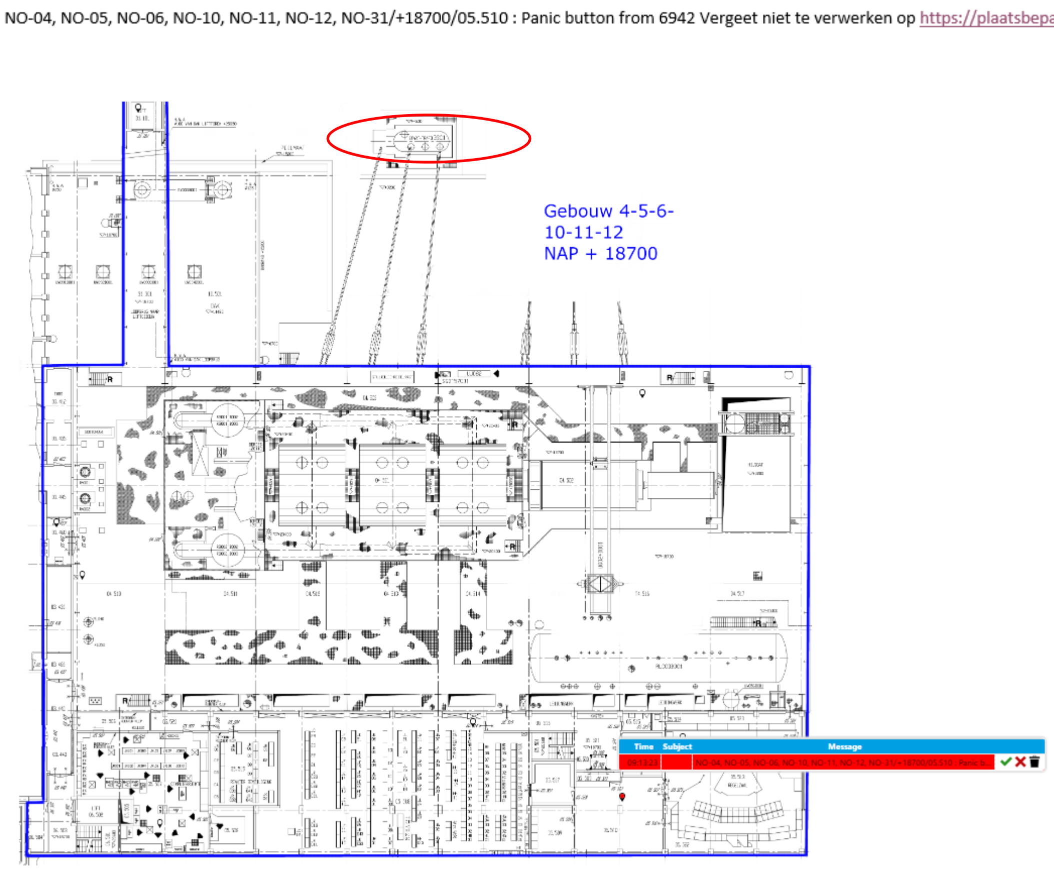
The purpose of the ‘Man Down’ system is to notify the Control Room when individuals out on plant are in distress or potential difficulty.

Description

In 2022, the ‘Man Down’ function was introduced to the phones on the plant. The ‘Man Down’ signal is generated automatically but can be manually activated. The signal is activated automatically when the phone is at a tilt angle of 60 degrees for greater than 20 seconds, recognizing that this is an unusual body posture.

When the alarm is activated, a signal is immediately sent to the Control Room via the Process Presentation System. An automatic e-mail is also sent to the Control Room with details of the phone number and identity of the individual in distress, as well as a map of the location.

The Control Room operator then takes immediate action to establish contact. If there is no response, the internal emergency number is immediately called and a security guard with a first aid kit is dispatched to the scene.



An example of the alarm and map information received by the Main Control Room via email.

Benefits

This system facilitates a much faster response in the event of an emergency, significantly improving the chance of survival in critical circumstances.

3.2(b) Good Practice: The plant has introduced Bluetooth hearing protection to aid with communication in high noise areas.

Purpose

The purpose of Bluetooth hearing protection with an integrated speaker and microphone is to ensure clear and concise communications during plant manipulation.

Description

At the beginning of 2020, during the COVID-19 pandemic, it became clear that social distancing in noisy environments was leading to a breakdown in clear communications during plant manipulations. To overcome these communication difficulties, and to avoid any adverse effects on operator performance, research was carried out to identify a suitable system, and a system was identified that could easily be integrated into different telecommunications systems. This system was implemented in the plant and enabled the maintenance of a high level of clear and precise communication while respecting social distance protocols.

Due to the adaptability of the new Bluetooth hearing protection, it has been seamlessly integrated into the communication system in the plant and can also be used for conference calls, as well as one-to-one calls. This has proven particularly beneficial during plant testing with multiple individuals working at different locations. The noise cancelling technology in the microphones associated with the hearing protection means that when an individual is speaking, the receiver hears their voice clearly and no background noise is audible.

Bluetooth hearing protection with an integrated speaker and microphone in use

Benefits

The Bluetooth headsets, and the integration of the headsets to the plant telecommunication system enable clear communication whilst still maintaining a high standard of hearing protection.

3.3 OPERATOR AIDS

3.3(1) Issue: The plant arrangements for the administration and control of operator aids are not sufficient to prevent the use of unauthorized operating documentation and other non-authorized materials.

During the review the team noted:

- The plant has produced a procedure for the authorisation, application and standardisation of operator aids; however, this procedure was not fully implemented, with progress estimated by the responsible individual to be approximately 30% complete.
- There is no official register for operator aids in the control room.
- The requirement for an official register of operator aids was not stipulated in plant documentation.
- An unauthorised operator aid detailing actions in case of an emergency was found stuck to an entrance door (Building 08.303). Instructions of this significance should be highlighted correctly, and in accordance with plant procedure, to ensure that individuals entering the room are fully aware of the safety precautions that they need to adhere to.
- An unauthorised operator aid with instructions on the operation of valve SD011S502, on the Condenser Vacuum System, was found in the Turbine Hall. The operator aid had also become detached and was on the floor near the valve.
- In Building 33.103, transmitter RS011P003 on the Back-Up Feedwater System was found with a handwritten temporary label attached to it by tape.
- Underneath the spent fuel basin leak check valves, there was an unauthorised operator aid advising the Field Operators to leave the valves open.
- An unauthorised operator aid with instructions titled ‘Tips and Tricks’ for operation of the Reverse Osmosis (RO) unit was found in the Demineralised Water station.
- An unauthorised operator aid titled ‘Regulation’, describing the operation of the RO system, was found in the Demineralised Water station.
- An unauthorised operator aid was found on the wall (Building 9, dosing room) describing the operation of a ‘Neutralization basin’ system that was no longer in use.
- An unauthorised operator aid with graphical information detailing the relationship between antifreeze and the refractive index was found on the wall in the chemistry laboratory.
- Unauthorised operator aids were found in the breathing apparatus cylinder area with ‘300 bar’ handwritten at the cylinder recharge points.

Without suitable arrangements for the administration and control of operator aids, and strict adherence to those arrangements, the likelihood of human error and mistake in operation of plant increases, leading to potential increased risk to nuclear safety and personnel injury.

Recommendation: The plant should enhance the arrangements for the administration and control of operator aids to prevent the use of non-authorized operating documentation and other non-authorized material.

IAEA Bases:

SSR-2/2 (Rev.1)

7.5. A system shall be established to administer and control an effective operator aids programme. The control system for operator aids shall prevent the use of non-authorized operator aids and any other non-authorized materials such as instructions or labels of any kind on the equipment, local panels, boards and measurement devices within the work areas. The control system for operator aids shall be used to ensure that operator aids contain correct information and that they are updated, periodically reviewed and approved.

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6.14. Operator aids may be used to supplement, but not replace, approved procedures or procedural changes. Operator aids should not be used as a replacement for danger tags or caution tags. A clear operating policy to minimise the use of, and reliance on, operator aids should be developed.

6.15. … An administrative control system should be established at the plant to provide instructions on how to administer and control the operator aids programme. The administrative control system for operator aids should cover, at a minimum, the following:

(a) The types of operator aid used at the plant;

(b) The responsibilities for reviewing and approving operator aids before their use;

(c) The procedures for verifying that operator aids include the latest valid information

Plant Response/Action:

Initially, the plant mapped out what types of operator aids are present in the plant. Before taking action, the plant deliberately invested time in understanding the background and root causes of the issue. This included an exploration of the cultural origins of the widespread use of operator aids. By understanding the 'why' behind the behavior, the plant created the foundation for a constructive and sustainable solution. Various interviews with employees were conducted to develop a plan to resolve this issue. A Deputy Shift Manager in training was appointed as coordinator for this topic.

Cause:

The root cause of the problem is that people possess information and wish to share it with others. Sharing information is considered important within EPZ. However, sharing knowledge must be secured according to applicable standards and guidelines. These standards and guidelines were not well known among employees and were not insufficiently described in company procedures. There is a culture behind this information that goes back 50 years. Due to the outflow of experienced personnel, many people regarded this information as valuable and as a desirable tool for being readily available.

Actions Performed:

- Plant tours have been performed to document the issue with photographs.
- The Operator Aids issue is explained during a leadership day to all leaders in order to create awareness and draw attention
- A plan of approach was drawn up, and available tools identified.

- A pilot was conducted to implement the plan and improve it using a PDCA cycle.
- A definitive plan was developed based on the outcomes of the pilot.
- A new procedure was created, distinguishing between Operational Notes and Operational signs (N07-00-004, chapter 7).
- A working method was developed for both categories.
- An extension request was submitted to ICT for the E-Soms Tracking and control system to add a registration for operational signs. This change has been implemented.
- An annual inspection of operator aids was initiated using a control instruction based on a printout of E-Soms reports.
- The inspection is initiated through a model work order in Asset Suite.
- A presentation and a 'how it should be done' reference sheet were developed to create awareness.
- A responsible person was designated for operator aids per building, in accordance with procedure N07-00-003.
- The new procedure was presented to the Operations shift teams.
- The new working method was then implemented.
- An initial effort was made to remove instructions from production-related buildings.
- Each building and room are now reviewed to check for the presence of unauthorized operator aids.
- Each shift starts with their team in smaller buildings to become familiar with the new working method.

Results and Effectiveness:

The result is that operator aids are now handled more appropriately in the buildings where the new process has been implemented, and the improvement is clearly visible. The identified operator aids have been removed, and the process for requesting legitimate operator aids has been initiated. Discussions are now taking place, and a culture is gradually emerging in which information is shared in a legitimate and structured way within the organization. Operator aids are now also included in LIF technical rounds so they can be documented and addressed accordingly.

Some blind spots may still exist, but these are limited and will ultimately be eliminated through the process of continuous improvement.

IAEA comments:

The plant has evaluated this recommendation and based on an analysis involving a review of the plant processes and procedures, different types of operator aids were found to be present in the plant. Discussions on the reasons for the widespread use of operator aids and interviews with employees identified a root cause of the problem and an 'action plan' was developed to fix the issue.

The root cause of the issue was identified as a 'wish of sharing' within the plant staff useful, convenient and simple information on operating practices, as sharing of information was considered as an important attribute of the plant culture. However, in many cases such distribution of information went far beyond the plant applicable standards, guidelines and procedures.

The action plan involved several administrative and technical arrangements and provisions towards elimination of unauthorised operator aids from the plant technological and industrial premises and enhancement of the plant processes and procedures focusing on the use of necessary operator aids.

Enhanced provisions in the procedures provide clear definition of the operator aids representing two types of documents known now as ‘operational notes’, and ‘operational signage’. The procedure includes specific requirement on the format, size and the way to place the operator aids on the plant systems, structures and components.

A system was established at the plant to administer and control an enhanced operator aids programme. A plant tracking tool for operator aids is focused on prevention of the use of non-authorized operator aids and any other non-authorized materials such as instructions or labels of any kind on the equipment, local panels, boards and measurement devices within the plant premises.

The plant eliminated non-legitimate operator aids from the plant technological and industrial premises and initiated a process for requesting legitimate operator aids, as necessary, and included this subject into technical rounds to monitor the way operator aids are used and handled by personnel and addressed identified deviations as appropriate.

During the plant tour the IAEA follow-up team did not observe any non-legitimate ‘operational notes’ and /or ‘operational signage’.

Conclusion: Issue resolved

3.4. CONDUCT OF OPERATIONS

3.4(1) Issue: The plant arrangements for the management of leaks are not sufficient to ensure the correct identification, management and timely resolution of leaks.

During the review the team noted:

- A leak was noted to be emanating from the top of the Turbine lubrication oil filters. Further monitoring of the leak over the course of the next three days showed that the amount of leakage noted in the first instance was excessive and that the leak had not been effectively managed in the days prior to the tour.
- A leak tag had been placed on the Turbine lubrication oil filters, with a work request number (WA 32647), but there was no defect tag present.
- The cleaning crew was tasked with leak management and clean-up, but some of this clean-up was done without the supervision of the Field Operator.
- The plant leak management procedure does not stipulate the required standard for the implementation of leak management on plant in service. It does not detail the requirements for the management of leak pads, nor does it detail the expected behaviours of the individuals managing the leak when the leak is on plant equipment in service.
- Oil leaks were noted under Turbine Bypass Valve actuators SF012S001 and SF013S011 (Building 04 414) with no defect tags or leak tags.
- A leak was noted under a seal oil pump in the Turbine Hall (SU021S010, Building 04 302). There was a leak mat in place, but no date on the mat, and no defect tag.
- A leak was noted near RL013S080 on the Main Feedwater System (Building 04 316). The leak had a defect tag on it (Defect Tag 237708), but no leak tag.
- During the test run of Diesel Generator 30, it was noted that a defect tag on a leak (small motor adjacent to valve EY033S003, Building 10 202) had minimal information on it and no date.
- A roof leak above the Main Feedwater Tank (Building 04 604, Defect Tag 298911) was noted during a tour with the Field operator. The defect was dated to 16 January 2022 and had not been rectified.
- Oil leakage was found on the floor area underneath EY041D001 in Building 33 103. The leak in question had no leak tag or defect tag.
- A leak from SC010S574 on the Turbine Oil System was noted in the Turbine Hall. There was a leak mat in place, but no defect tag or leak tag.

Insufficient leak management arrangements could lead to the deterioration of plant equipment and the inadvertent operation of plant equipment.

Suggestion: The plant should consider enhancing its arrangements for the management of leaks in order to ensure the correct identification, management and timely resolution of leaks.

IAEA Bases:

SSR-2/2 (Rev.1)
7.10. Administrative controls shall be established to ensure that operational premises and equipment are maintained, well lit and accessible, and that temporary storage is controlled and limited. Equipment that is degraded (owing to leaks, corrosion spots, loose parts or damaged thermal insulation, for example) shall be identified and reported and deficiencies shall be corrected in a timely manner.

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4.40. Operating personnel who are assigned the task of conducting shift rounds should be made responsible for verifying that operating equipment and standby equipment operate within normal parameters. They should take note of any equipment that is deteriorating and of factors that might affect environmental conditions, such as water leaks, oil leaks, broken light bulbs and changes in building temperature or the quality of the air.

4.41. Any problems with equipment that is observed during shift rounds should be promptly reported to the control room personnel and corrective action should be initiated. Factors that should typically be noted and reported include the following:
(a) Deterioration of material conditions of any kind, including corrosion, leakage from components, accumulation of boric acid, excessive vibration, unfamiliar noise, inadequate labelling, foreign bodies and deficiencies necessitating maintenance or other action.

Plant Response/Action:
At the time of the OSART mission in 2023 the plant did not have a separate procedure for the management of leaks.

A trend of leaks detected by operations and by the cleaning crew was developed in an undefined manner and was not clearly described.

Cause:
There was no clear work process and no separate procedure that described the correct identification, management and timely resolution of leaks. A total overview of all leaks was missing.

Actions Performed:
Identification and classification of leaks have been improved. When making work requests, information about the leak medium and leak size are added. A standard table has been established for leaks, the medium and size determine the leak category: whether a leak is detectable, small or large.

Leaks are monitored in a new way by operations according to the assigned leak category. Monitoring by the cleaning crew is standardized, the control room determines if supervision by field operator is required.

Operational teams have been instructed and are in the process of checking and correcting the identification and information of all existing leaks. The cleaning crew have been instructed and applied the new procedure.

In cooperation with the KE (Equipment Reliability) department, a new leakage category has been established ‘acceptable and accepted leak’.

A dashboard has been created which gives an overview of all leaks.

A new leak management procedure has been developed and implemented (PU-N07-03-006). It has been communicated through a Toolbox to all departments.

Results and Effectiveness:
Leak management is now formally described in a procedure. At the plant, leak identification and classification has improved. The leaks are routinely monitored by operations and by the cleaning crew. There is an up-to-date overview of all leaks.

IAEA comments:

The plant has evaluated this suggestion and based on an analysis involving a review of the plant management system provisions, identified a cause of the problem as a lack of clear work process, procedures and operating practices necessary to ensure correct identification, reporting, categorising, tracking, trending and timely fixing of leaks.

An action plan involved several administrative and technical arrangements and provisions towards development of a process for the leak management. This was supplemented by a detailed procedure describing the way a leak is to be handled by respective organizational units such as operations, maintenance, equipment reliability department, cleaning department and new work review group. A procedure provides clear criteria for categorization of leaks and an enhanced tagging system is used to identify the location of the leak. The procedure also specifies an order for the monitoring and control of the active leaks and the associated plant personnel actions at different levels of the organization.

A computational tool was established at the plant to administer and control the leak management process. A plant tracking tool (a dashboard) for leak management provides full scope of data on the current registered leaks and a status of assigned plant actions toward the final resolution of a leak. A set of key performance indicators has been introduced at the plant and provides necessary data for the control of the leak management process. The plant demonstrated a positive trend in decreasing the number of registered leaks.

During the plant tour the IAEA follow-up team did not observe any unidentified leaks but confirmed the correct application of the new process and procedures on the leak management in the field.

Conclusion: Issue resolved

4. MAINTENANCE

4.2. MAINTENANCE FACILITIES AND EQUIPMENT

The plant arrangements for corrosion protection are not sufficiently robust. In the plant procedures, there were no information regarding the actions to be taken depending on the level of corrosion, how to deal with corrosion damage and also time at risk was not taken into account. The team identified some shortcomings such as insufficient corrosion protection on several valves and struts in the essential cooling water system, corroded bolts and nuts flanges on the emergency feed water back up system. Some other valves of non-safety related system were also corroded. The team therefore made a suggestion in this area.

4.3. MAINTENANCE PROGRAMMES

The plant had established the comprehensive maintenance programme on the level of preventive and corrective maintenance. The preventive maintenance programme for safety related equipment and systems is based on ‘OPTIMIZER’ - a large database containing guidance and periodical requirements for safety and non-safety equipment reliability. This database also includes tools for Failure Mode Effect and Criticality Analyses (known as FMECA). FMECA combines external operating experience with industrial safety instructions and the expected effect in case of non-operability of the equipment. Before starting work, the Last-Minute Risk Analysis (LMRA) was used as a precaution to avoid human error. The team recognized these tools as good performance.

The plant and a contractor have developed a dedicated manipulator that combines visual testing and laser measurements to assess the quality of lapping activities. The manipulator helps to reduce the dose rate of the personnel and it checks valve seat surface in much more detail. The team recognized this as a good performance.

4.10. CONFIGURATION CONTROL

The plant does not have a well-defined strategy on how to maintain and remove redundant equipment. There were examples of redundant equipment within the plant which have been in place for some time. The team encouraged the plant to review its arrangements for the removal of redundant equipment.

DETAILED MAINTENANCE FINDINGS

4.2. MAINTENANCE FACILITIES AND EQUIPMENT

4.2(1) Issue: The plant's corrosion protection and inspection programmes are not sufficiently robust to monitor safety and non-safety related systems, structures and components (SSCs) and to timely address its deficiencies to ensure safe operation.

During the review the team noted:

Corrosion on safety related systems:

- Corrosion on valves of essential cooling water system (VF30S001, VF31S004, VF30S014, VF30S013, VF30S011).
- Heavily corroded bolts, nuts flanges on emergency feed water back up system (RS system), bunkered safety related equipment.
- Corrosion of pipe stand TF002H103 – a structure of component cooling water system.
- Heavily corroded strut of essential cooling water system (VF007H106) with a defect tag from 29 April 2020.

Corrosion on non-safety related systems:

- Corrosion of valve for steam condensate circuit (RP013S015), no defect tag in place.
- Corrosion of valve for main cooling system (VC012S004), no defect tag in place.
- Corrosion of valve for essential cooling water system (VF005S061), no defect tag in place.
- Corrosion of valve for steam generator blowdown system (RY020S074), defect tag in place.
- Corrosion of valve for conventional intermediate cooling system (VG002F501).
- Corrosion of drainage trough near a valve for main cooling system (VC system).
- Corrosion of electrical cables support.
- Corrosion of bolts for main cooling system (VC system).
- Corrosion of valve for main condensate system (RM073S002).
- Corrosion of valve for feed water system (RL011S011).
- Corrosion of valve for dewatering condensate system (RT012S015).
- Corrosion of tank holder for water separate condensate system, near RK000P501 in the turbine hall.

The plant requirements, procedures, expectations:

- Risks and effects of corrosion on SSCs were not always taken into account during work planning, and resolution of defects were not always prioritized commensurate with the potential risk of SSC failure.
- In procedure, N07-00-002, there was no information regarding the actions to be taken depending on the level of corrosion (corrosion on nuclear systems are not accepted at the plant) and how to deal with corrosion damage (time at risk is not taken into account).

– In the system health report for the component cooling water (TF) system (safety related system) corrosion effects were mentioned. The work request has been approved, but no corrective actions have been taken.
– In the last five years, 70 work requests regarding corrosion have been made, eight work requests were in the status ‘Approved’ (working orders have not been issued), 10 work requests were in progress.

Without appropriate response and implementation of corrective actions, corrosion could affect safety and non-safety related systems, structures and components and jeopardize the safe operation of the plant.

Suggestion: The plant should consider enhancing its corrosion protection and inspection programmes to ensure timely identification, monitoring and correcting of deficiencies on safety and non-safety related SSC, whose failure could jeopardize the safe operation of the plant due to corrosion effects.

IAEA Bases:

SSR-2/2 (Rev.1)

7.10. Administrative controls shall be established to ensure that operational premises and equipment are maintained, well lit and accessible, and that temporary storage is controlled and limited. Equipment that is degraded (owing to leaks, corrosion spots, loose parts or damaged thermal insulation, for example) shall be identified and reported and deficiencies shall be corrected in a timely manner.

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Visual inspection
10.16. A visual inspection should be made to provide information on the general condition of the item, component or surface to be examined, including features such as the presence of scratches, wear, cracks, corrosion or erosion on the surface, or evidence of leaking. Surface replication as a method of visual inspection may be considered acceptable, provided that the resolution at the surface is at least equivalent to that obtainable by visual observation. Any visual inspection that involves a clean surface for the proper interpretation of results should be preceded by appropriate cleaning processes.

Plant Response/Action:

The plant’s corrosion protection and inspection programs were not sufficiently robust to monitor systems, structures and components (SSCs) and to timely address its deficiencies.

Summary of cause:
Although strategies for monitoring, mitigation and correction were described in the aging management procedure for external degradation of mechanical systems, these were insufficiently applied. There was an apparent disconnect between the aging management team and the maintenance and ER department on this topic. This resulted in a lack of active monitoring, and a lack of formal assessment in the case of noted and reported deviations.
In addition, the overall station works management backlog, caused mainly by maintenance staffing shortcomings over the past 5 years and insufficient prioritization, made it possible for noted issues of external corrosion to be left open without a clear explanation and tag. These

seemingly accepted degraded conditions might have created some complacency on the topic of external conditions of equipment.

Summary of improvement actions:

This long-term suggestion was integrated into the ongoing ER improvement plan. Several specific actions were added and initiated over the last years. As the (re)new(ed) ER team got up to speed (see TS chapter), the assessment of corrosion deviations in the respective systems gradually got more attention. It is the duty of the Reliability Engineers to judge if any deviations in their systems, including corrosion, can become critical and to raise concerns if the resolution takes too long.

The direct action taken was to provide significantly more coating resources/budget at civil maintenance department in 2024 and 2025. This has led to a catch up in resolution of corrosion issues. The cooling water intake building is undergoing a structured and scheduled improvement with respect to the corrosion situation and prevention.

Recently the relevant aging management procedure for external degradation (including corrosion) was updated (PU-N12-50-442). A guideline for formal corrosion damage analysis and assessment is in development and will be included as a working document in conjunction with this procedure.

For inspective and mitigative functions a new separate 'Coating and CUI team' will be set up among mechanical maintenance, civil maintenance, equipment reliability and inspection. They will be responsible for the execution of both preventive inspections and enhancements, as well as effective and combined corrective action in case any issues are found. The strength of this team will be in the combination of inspection and direct action, including wall thickness measurements, (re)new(ing) coatings and insulation.

For the TN/UV cold water systems a long-term plan is being drawn up, following a risk-based approach. The first part of this scope will be used as a pilot for the new team to get started, the combined inspection and correction works will be scheduled in Q3 2025. After this pilot a long-term schedule will be made for the coming years.

Results and Effectiveness:

The general corrosion situation across the plant has improved. Awareness has increased and acceptance is reduced. The improved attention and additional resources for coating have performed a catch up on the backlog of reported and present corrosion in the plant. Other corrosion observations were and are assessed and will be taken care of with priority coming from this assessment.

IAEA comments:

The plant has analyzed and assessed this suggestion. The root cause is that the plant had not applied strategies for monitoring, mitigation and correction. It was identified that there was a disconnect between the ageing management team, maintenance and the system engineering team.

This disconnection resulted in a shortage of active monitoring and lack of formal assessment when deviations were noted and reported. Additionally, shortcomings of prioritization and lack of resources over time created a backlog that together with an acceptance for the deviations, built up the situation for the plant as described in the issue.

The plant has developed an action plan and has set up a cross-functional team that identifies deviations, plans the handling, and prioritizes handling of deviations with respect to safety. In parallel the Equipment Reliability (ER) function has been reorganized so scoping, assessment and prioritization now have a clear responsibility. Furthermore, the plant has thoroughly updated the procedure (PU-N12-50-442) and that is to be released at the end of May 2025.

The plant's ambition is to have a proactive approach when it comes to handling corrosion and an important step shall be in place in 2025 Q3 starting with a pilot, TN030 piping and branches, that has been selected from risk-based analysis. Thereafter a prioritized long-term plan for defined improvement areas shall continue. It was also identified that the plant has made benchmarks that have influenced their strategy to solve the issue.

In parallel with taking the step from reactive to proactive corrosion management, the plant has, after the OSART review in 2023, made several improvements in handling corrosion. For instance, in the sea water cooling system, condensate drain tank supports, exhaust piping of Emergency Diesel Generators, reactor building access crane and transformers on 150kV-level. The number of faults reported in the area of corrosion has increased and is steadily increasing and, according to the manager responsible, this is a result of the increased focus in this area. From a financial perspective the budget for coating has increased more than 250% since 2023. Analyzing the delivery (i.e. the realized budget) it appeared to be even larger than the initial budget.

During the field visit by the team, at several locations in the turbine building and at the intake water channel building it was identified that multiple actions had been done to handle corrosion and that there were ongoing projects in these areas. It was also noted that in some areas where corrosion mitigation actions had not been started, the main reason was due to integration reasons with the scheduled full component replacement projects in 2025 and 2026.

The stepwise approach for resolution of the issue has resulted in visible effects in the plant and are a base for robust handling of future corrosion effects to minimize the impact on the safe operation of the plant.

Conclusion: Issue resolved

5. TECHNICAL SUPPORT

5.1 ORGANIZATION AND FUNCTIONS

Technical support functions responsibilities as well as levels of authority were defined in the organization. Processes for modifications and configuration management were also well described and understood within the organization. The plant had recently developed a structure and process for Technical Authority and Design Authority in order to further strengthen design integrity. The implementation was not complete; however, it was being implemented in accordance with the plan. The team encouraged the plant to continue its efforts to further strengthen the process for design integrity.

For modifications, the plant had developed a graded approach which was based on the safety significance of the modifications. The graded approach implied four different categories and configuration control was integrated within all four categories. The plant performs safety reviews and independent reviews for modifications in an adaptive way, depending on the safety significance. However, the team identified that expectations for independent review at the plant are not fully clear and encouraged the plant to strengthen the expectations for independent review.

The plant has developed a programme of system health for monitoring, control and analysis of the plant status and performance for maintaining the safety and reliability of the plant. Systems were divided into three different categories where the first category contained all systems with a safety function. According to the plant's requirements, the system health reports of these systems should be updated yearly, and actions should be reviewed every third month. The team identified that the performance in this area was not in line with the plant requirements. For example, only three out of 21 systems important for safety were updated 2022, appointed actions from system health reports identified in 2018 for fire suppression system were still open and there was no cumulative safety assessment for open actions from system health reports. In addition, the team identified shortcomings in the plant obsolescence process for instance lack of appropriate register identifying obsolete components and examples of failures of obsolete components without a qualified component for replacement. The team made a suggestion in this area.

5.4 AGEING MANAGEMENT

The plant is in the stage of long-term operation (LTO). The plant activities for long-term operation, specifically in the area of ageing management, are done during normal operation and in particular when performing the Periodic Safety Review. The team identified a good practice using a self-developed tool - Mechanism Matrix' used to verify comprehensiveness of ageing management activities, improving the overview of coordination requirements and traceability of relevant ageing management activities.

DETAILED TECHNICAL SUPPORT FINDINGS

5.1 ORGANISATIONS AND FUNCTIONS

5.1(1) Issue: The plants System Health Monitoring Programme and Obsolescence programme are not sufficiently robust and prioritised to ensure that risk of degradation of the plant systems, structures and components is minimised.

During the review the team noted:

There were shortfalls in the plant's System Health Monitoring programme:

- Out of 21 systems identified by plant to be important for safety and reliability only three of those 21 systems had an updated SHR during 2022. The plant requirement is that all systems that are important for safety shall have an updated system health report yearly to maintain safe and reliable operation over time.
- The plant had an expectation to update System Health Reports (SHR) important for safety every 12 months. However, in 2021 only 13 SHR were updated out of 21, in 2020 only five SHR were updated, in 2019 only 16 SHR were updated.
- In 2016 it was identified that a centrifugal pump UF001D002 had a vibration pattern that could affect the pump's ability to fulfil its function when needed. This was further emphasized in a system health activity for fire suppression system (System Health Reports KO-19-052, and KO-20-068) in 2018 and 2019, despite this, the actions were still open.
- In system health activity and report KO-18-125 one of the findings was that a leakage of two valves UK000S00X was identified in 2018. This was immediately posted in the work order system; however, the valves had not been replaced and the issue remained and actions from SHR were open.
- 58 actions from System Health Reports were open; 29 of these 58 actions did not have an update of the status as requested by the plant requirements and there was no regular check of actions from Systems Health Reports every third month as required by plant expectation.
- There was no cumulative safety assessment for open actions from System Health Reports.
- The number of plant status deviations was 47 which exceeded the plant target of 30.
- The number of plant status deviations had since third quarter 2020, exceeded the target threshold of 30, except for the period of second quarter in 2021.
- Of the 47 plant status deviations 10 were related to nuclear safety.
- A modification for the Nuclear Waste Treatment in 2018 caused an unintentional alarm in the Main Control Room. The solution for solving the operator burden was to pull out the relay and handle it as a plant status deviation that should have been resolved in a modernization project 2021 but was further delayed until 2023.
- During a project modification in 2021 the airlock between the auxiliary building and containment, a deviation was identified during commissioning and temporarily solved as a plant status deviation which was still in place at the time of the OSART review. More than 25 plant status deviations have not been solved within six months or during the next outage, which was not in accordance with plant requirements.
- There are no clear expectations for cumulative safety assessments of the total amount of plant status deviations including temporary modifications.

There were shortfalls in the plant Obsolescence process:

- During the outage of 2021, a temperature transmitter M4316-A13 was outside its acceptance criteria and had to be replaced. The original component was obsolete, and the replacement component had not been identified in advance or qualified for the specific application and that had to be done before the installation.

- An isolation barrier module of type B M4200 had to be replaced. The component was obsolete and the proposed replacement component (P32000P0/11-KTA) had not been identified in advance or qualified for the specific application.
- The register for identifying obsolescence components was under development and contained 82 components of which 60 were not prioritized.
- During an interview with plant staff about obsolescence it was stated that the plant understood the importance and needed to develop an obsolescence programme; both building up the component database and change their perspective from reactive to more proactive to know in advance how to handle obsolescent components and associated risks.

Without a structured, systematic and prioritized arrangements for system health monitoring and obsolescence there is a risk of degradation of systems, structures and components jeopardising the plant safety and reliability.

Suggestion: The plant should consider strengthening its programmes for System Health Monitoring and Obsolescence to ensure that they are robust and prioritised to ensure that the potential risk of degradation of the plant systems and components is minimised.

IAEA Bases:

SSR-2/2 (Rev. 1)

3.2. (e) Review activities, which include monitoring and assessing the performance of the operating functions and supporting functions on a regular basis. The purpose of monitoring is: to verify compliance with the objectives for safe operation of the plant; to reveal deviations, deficiencies and equipment failures; and to provide information for the purpose of taking timely corrective actions and making improvements. Reviewing functions shall also include review of the overall safety performance of the organization to assess the effectiveness of management for safety and to identify opportunities for improvement. In addition, a safety review of the plant shall be performed periodically, including design aspects, to ensure that the plant is operated in conformance with the approved design and safety analysis report, and to identify possible safety improvements.

4.37 The appropriate corrective actions shall be determined and implemented as a result of the monitoring and review of safety performance. Progress in taking the corrective actions shall be monitored to ensure that actions are completed within the appropriate timescales. The completed corrective actions shall be reviewed to assess whether they have adequately addressed the issues identified in audits and reviews.

4.38 Controls on plant configuration shall ensure that changes to the plant and its safety related systems are properly identified, screened, designed, evaluated, implemented and recorded. Proper controls shall be implemented to handle changes in plant configuration that result: from maintenance work, testing, repair, operational limits and conditions, and plant refurbishment; and from modifications due to ageing of components, obsolescence of technology, operating experience, technical developments and results of safety research.

SSG-48

2.25. Nuclear power plant safety can be impaired if the obsolescence of SSCs is not identified in advance and corrective actions are not taken before the associated decrease in the reliability or availability of SSCs occurs.

2.26. Management of obsolescence is part of the general approach for enhancing nuclear power plant safety through ongoing improvements in both the performance of SSCs and safety management

6.1. Technological obsolescence of the SSCs in the plant should be managed through a dedicated plant programme with foresight and anticipation and should be resolved before any associated decrease in reliability and availability occur.

6.2. A technological obsolescence programme should be prepared and implemented to address all SSCs important to safety and the spare parts required to maintain those SSCs.

6.3. The technological obsolescence programme should involve the participation of the engineering, maintenance, operations and work planning units, plant senior management and supply chain organizations.

6.4. The technological obsolescence programme should be made available to the regulatory body for review and assessment at a level of detail defined by national regulatory requirements.

SSG-71

6.1. Modifications that are implemented for a limited period of time should be treated as temporary modifications. Examples of temporary modifications are temporary bypass lines, electrical jumper wires, lifted electrical leads, temporary trip point settings, temporary blind flanges and temporary defeats of interlocks. Temporary modifications also include temporary construction and installations used for maintaining the design basis configuration of the plant in unanticipated situations. In some cases, temporary modifications can be made as an intermediate stage in making permanent modifications.

6.7. In the safety assessment and review of all proposed modifications (temporary and permanent), any existing temporary modifications and the cumulative safety significance of the proposed change should also be considered.

Plant Response/Action:

The plant’s System Health Monitoring Programme and Obsolescence programme were not sufficiently robust and prioritised to ensure that risk of degradation of the plant systems, structures and components was always minimised.

Without structured, systematic and prioritized arrangements for system health monitoring and obsolescence there was a risk of degradation of systems, structures and components jeopardising the plant safety and reliability.

As two separate topics are grouped in this suggestion, the following is split over the two topics.

System Health Monitoring Program

Summary of underlying causes:
The System Health Program was strongly lagging behind in execution and resolution of corrective or preventive actions. Lack of staffing, high data collection efforts needed, too much involvement of system engineers in daily operational and maintenance support and improper division of responsibilities all contributed to the ineffectiveness of the System Health Program.

Summary of improvement activities:

– The ER-function has been re-organized since May 2023 with the initiation of a new main organizational department ‘Equipment Reliability’ (internal acronym: KE), fully separated from Maintenance, and roles and responsibilities have been reconfirmed. The KE department has been repositioned in the organization, residing directly under the Plant Manager. The ER- group, now being an independent main department, also means the ER manager is part of the Site Management Team, confirming the authority of the ER group and assuring the plant wide focus on securing Equipment Reliability.

– The engineers in the new ER department are now all dedicated Reliability & Component Engineers, only occasionally assisting maintenance department on true engineering challenges. Their System Health monitoring responsibilities are clearly defined in the function description.
– The setting up of the ER team in the new KE department not only resulted in filling the longstanding vacancies, but to support the focus on ER and provide adequate resources for the LTO-2 analyses. Also, additional staffing was hired, making the ER department a 19-person team from the end of 2024 onwards (instead of only 3-5 FTE fully dedicated to system health in the period 2019-2022).
– A renewed schedule has been set up and followed up for the system health reporting and corresponding system walk downs. The focus was first on the most relevant and overdue system health reports and will from 2025, be on assuring the follow-up and compliance with the updated frequency.
– The system responsibilities have recently been divided among the engineers, increasing ownership and allowing knowledge build up.
– Integrated (cross-functional) System Walkdowns have been restarted, involving design/ageing, operations and maintenance.
– Data collection on system performance, defects and deviations and maintenance feedback was simplified and automated, allowing the engineers to spend more time on analysis and trending, instead of on data gathering.
– The scoring of system performance and risks over the system health reports has been more standardized and the system health reports have been extended to include both performance and concerns from surveillance, ISI and Ageing Management.
– Long term planning of system major works and replacements including outage scoping now also resides in the ER department, allowing better risk-based prioritization and communication.
– A risk rating has been introduced for the SH actions and action tracking is improved. Overdue/historic SH-actions have been checked, administration corrected and remaining open points reprioritized.
– Procedures for the SH program and reporting were updated to reflect new ways of working and criteria applied (PU-N12-60-004/005).

Results and Effectiveness:

The percentage of System Health Reports updated according to the procedural frequency was improved from 3% in 2022, via 20% in 2023 to 71% in 2024. The target for 2025 is 90%, including several new systems (groups).

The 22 SHR’s written in 2024 resulted in 55 actions, of which 20 have been completed already.

The action backlog from earlier years has been greatly reduced.

The attention for reliability has notably increased throughout the plant through the continuous presence of KE in all relevant committees and process meetings of OP/WM/EC.

Treatment of SHR in Operational Management team meetings (acting PHC) has become regular (several SHR's per month), improving the cross-departmental attention for System Health concerns and measures.

Although new deviations and risks that are discovered during the updating of the System Health Reports result have not yet resulted in an increased overall SH, the overall feeling was that issues were being identified and actions set to address the deviations. Also, the effectiveness of the resolution of issues is increasing, with an increased number of inspections.

The plant reliability over the last years has been good, but it is also clear that almost all inspections and overhauls that are now increasingly requested by the ER department have shown to be necessary, leading to the finding and fixing of known and hidden defects. The next step is obviously to become ahead of all issues by assuring no unknown plant deviations or risks exist or can occur.

Obsolescence

Summary of underlying causes:

Up to 2023 there was no dedicated Technological Obsolescence Program with anticipation to prevent potential decrease in plant's system availability and reliability due to obsolescence of SSCs. Late 2022, as part of the overarching Spare Parts Optimization project EPZ initiated Technological Obsolescence Management. The OSART mission witnessed the status of Obsolescence Management in its initial project development phase, when the first steps were taken into registering obsolete components. At that moment in time, no dedicated resources were allocated to the project, nor was there any structured process, procedure or priority in the obsolescence register.

Summary of improvement activities:

– The setup of the Technological Obsolescence Management Programme was stimulated by allocating additional resources to the Spare Parts Optimization Project and vacancies were published to increase capacity at the Engineering department with amongst others the purpose of setting up a Technological Obsolescence Management programme. The vacancy was successfully filled as of September 2023.

– From that date on, a structured method of registering obsolete SSCs was set up, utilizing a centralized e-mail address to enable ease-of-use notification of obsolescence. From the initial obsolescence notification, the obsolete component is registered and prioritized. Prioritization is established by determining the (safety) risk for the plant, in line with IAEA SSG-48 and TOP401, taking the actual stock quantity, historic usage, Mean Time To Failure (MTTF), SPV and effect severity (component safety class) into account. Besides, the Equipment Reliability department is asked to judge priority and can add a multiplication factor. As an outcome, the obsolescence register provides priority for the resolution of registered obsolete components. Actions are allocated to specific resources throughout the plant organization, involving engineering, maintenance, operations, work planning and supply chain departments.

– The process is written down in the formal procedure PU-N12-45 Technological Obsolescence Management, and communication has been done to familiarize plant staff with this new process.

- As the Obsolescence Register and Process execution evolved, it allowed for the development of performance indicators providing insights in programme status and progress. Amongst others the number of annual obsolescence items noted and solved by safety classification category are tracked.
- Due to the direct relation with plant reliability, obsolescence will be made part of the System Health reports as of mid-2025, enabling the Reliability engineers to take obsolescence of components related to their system into account.
- EPZ has joined the International Nuclear Utility Obsolescence Group (INUOG), is participating in VGB and FROG committees and is actively approaching colleague utilities to learn from their obsolescence program approach and experiences.
- It has become clear during the project that the role of obsolescence coordinator has to be strengthened permanently and that a dedicated function is most suitable for its success. EPZ wrote a new function description ‘Obsolescence Management Program Owner’, following the functional description of IAEA TOP401. The vacancy is expected to be opened within the organization by mid-2025.
- The Spare Parts Optimization Project is due to close off and will formally transfer the Technological Obsolescence Program into the organization in the second half of 2025. While the project is nearing transfer to the organization as a dedicated program, the project team is aiming towards the first proactive obsolescence management steps. Where the current approach of the project/program is reactive, the project team is developing a list of parts, which are part of the subsequent-LTO scope and classed as ‘critical’. From the analysis, a list of parts will be provided to the supply chain department. In their turn, the supply chain department will prioritize the list of materials by order of supplier (risk) data. The prioritized list is intended to be used for approaching the supplier/OEM-base proactively to determine (obsolescence) status of their portfolio.

Results and Effectiveness:

Following and adhering to IAEA SSG-48 and TOP401, EPZ has developed a procedure, process and insight in the plant’s obsolescence status. The register of obsolete components is prioritized, and solution methods are in place. The project is developing new obsolescence solutions such as an Item Equivalency Evaluation (inspired by the INUOG) and will look in the future at Commercial Grade Dedication (CGD) and Reverse Engineering.

Since the restart of the project in September 2023, the plant has recognized 419 obsolete components and have solved 24% of those. Recognizing the need to solve more obsolescence challenges, EPZ is hiring a dedicated programme owner and more engineers for processing solutions. Adhering to the LTO-requirements and to have more of an “early warning system” towards potential obsolescence, EPZ is developing a list of parts which will form the basis to approach the OEM/supplier-base proactively.

The purpose and all actions of EPZ’s Technological Obsolescence Management Programme lies at prevention of obsolete components affecting safe and reliable operation. By positioning clear ownership and organisational resources, and by including obsolescence in the System Health Reports, insight in the potential risk of obsolescence for plant reliability is provided. This provides the prioritization of solutions and minimization of the potential risk of degradation of the plant systems and components.

IAEA Comments:

The plant has carefully assessed this suggestion and concluded that the main causes were lack of staffing, prioritization and improper division of responsibility that contributed to ineffectiveness of the system health program.

Considering the obsolescence program the plant came up with a conclusion that the root cause was a lack of dedicated programme, resources and processes in place to manage the obsolescence process and handle the challenge of obsolescence.

Referring to the above causes the plant has developed an action plan to enhance its ability to increase the robustness of their system for the health monitoring programme. The improvement activities have been implemented in a timely manner and results and effectiveness points so far in the right direction.

The function for equipment reliability has since May 2023 been positioned directly under the Plant Manager and the Equipment Reliability (ER) manager is a part of the site management team. This gives a prerequisite and basis for assuring plant wide focus on equipment reliability that is a part of the company business plan and strategy.

From a staffing point of view the organization of the ER Team has increased the number of Reliability and Equipment engineers from seven up to 19 persons at the end of 2024. The system responsibilities have been divided among the engineers and cross-functional system walkdowns have been restarted. In addition, data collection on system performance, defects, deviations and maintenance feedback have been standardized, which enables the engineers to spend more time on analysis and trending.

The plant is seeing several improvements on aspects related to this issue, such as the number of updated system health reports, which has improved from 3% in 2022, 20% in 2023, 71% 2024 and the objective for 2025 is 90%. However, the plant aims towards 100%. The handling of system health reports actions has improved together with reducing the historical backlog and monitoring and control demonstrates that there were 67 open actions and at this stage none of them were overdue and times for completion were considered reasonable.

The area of equipment reliability has a set of KPIs, and the System Health Index gives a good overview of the status and the trends. The System Health Index shows that out of 43 systems, 12 have not received the yearly update as required and nine of them were safety systems. The plant was aware of this status and was convinced that the target of 90% update will be met at the end of 2025. Since Q1 2020 the Equipment Reliability Index has been above 75 and reached 87 in Q1 2025 demonstrating a result slightly below the company target of 90 or above. The trend of Equipment Reliability Index (ERI) since 2020 has been slightly increasing. However, the plant had an unplanned shutdown in May 2025 that will affect ERI.

The plant has not experienced any reactor scrams since 2018, but since 2023 there have been two unplanned shutdowns, and one outage extension related to ER:

– December 2023: generator/turbine trip due to current measurement coil, 4-days of forced outage (reactor stayed at 30%), start-up delayed by 1 day due to motor drive defect of motor operated valve in feed water system.
– Outage 2024: start-up delay of five days due to external leakage of Pressurizer Spray valve YP001S046

– May 2025: unplanned shutdown of seven days due to external leakage of Pressurizer Spray YP001S047 valve, and this was a rework from scheduled PM work in outage 2025 in April, so not a primary ER cause

At the end of 2024, it had appeared that the plant did not meet the KPIs related to equipment reliability; ERI = 88 (<=90), open actions in safety systems = 9 (=>5), system health index = 71 (85).

The project for obsolescence restarted in 2023 and the plant has developed procedure, processes and insights on the plant's obsolescence status. A structured method for registering obsolete Systems Structures and Components (SSCs) has been set up and at the time of the OSART Follow-up mission, 419 articles has been identified and registered. Of these 419 articles 267 was solved or under treatment and 152 articles has not yet been treated. Of the 152 articles which have not been treated yet, 25 articles are used in safety related systems (1E).

There were 316 articles, which are in treatment or not treated yet, there are 72 articles that has no replacement in stock and of these, 22 articles are related to safety. There exist replacement plans that will continue for several years. For example: there are multiyear Modification Plans being implemented for replacement of obsolete level measurement instruments (WP 30-2616) and projects such as replacement of obsolete electric actuators (Project no. P9830).

At the time of the OSART Follow-up mission, there were no developed KPIs for obsolescence, as this was planned to be integrated into the process from 2026. However, the project has developed a relevant set of statistics that shows status and progress.

Next step for the plant is to integrate the obsolescence project in the line organisation in 2025, the relevant procedures for this have already been produced and approved. In addition, work is underway to integrate obsolescence status reporting in the system health report to get a more thorough and relevant picture of the system risks.

Conclusion: Satisfactory progress to date.

5.4. AGEING MANAGEMENT

5.4(a) Good practice: The plant has developed an easily applicable ‘Mechanism Matrix’ to visualize ageing management activities in order to ensure effective ageing management of all structures, systems and components (SSCs) in scope of its plant-level ageing management programme.

The purpose of the ‘Mechanism Matrix’ is to verify comprehensiveness of ageing management activities, improve the overview of coordination requirements and traceability of relevant ageing management activities. The plant has introduced the visualization of these aspects in matrices and included them in living ageing management review documents.

Description

Visualization of ageing management activities consists of representing Ageing Management Programmes (AMPs) for all relevant ageing mechanisms at every location in the SSC under consideration.

	Thermal Ageing (CAM 3.1)	Wear/fretting (CAM 3.3)	Relaxation (CAM 3.4.2)	Thermal Fatigue (incl. EAF) (CAM 3.5)	Boric Acid Corrosion (BAC) (CAM 3.6.1.3)	Pitting (CAM 3.6.2.1)	Crevice corrosion (CAM 3.6.3.1)	IGSCC (CAM 3.7.1.1)	PWSCC (CAM 3.7.1)	Underclad cracking (CAM 3.8)
Outside area steam generator					461					
Primary chambers and nozzles				450		403				TLAA
Division sheet				450		403			471	
Tube bundle		481				481	481			
Tube sheet				450			481		471	
Rolled plugs		481					481			
Explosion welded plugs						403	481			
Welded plugs									471, 481	
Manhole covers (gasket)	401									
Nozzle dam bolts						403				
Dewatering lines						403		470		
Closure bolting			440		461	440				

Visualization of AMPs for the primary side of the steam generators

In the above example, the ageing management review identified relevant ageing mechanisms to be managed for the primary side of the steam generators. Relevant AMPs were identified for each of these mechanisms.

In this example, the following AMPs were identified:

- AMP 401 Maintenance (Preventive replacement of gaskets)
- AMP 403 AMP Water chemistry
- AMP 440 AMP for bolting used in pressure retaining components
- AMP 450 AMP for monitoring of thermal fatigue
- AMP 461 AMP for Boric Acid Corrosion
- AMP 470 AMP for Stress Corrosion Cracking
- AMP 471 AMP for Primary Water Stress Corrosion Cracking (PWSCC)

- AMP 481 AMP for steam generator tube bundle

Underclad cracks in the primary chambers and nozzles are adequately addressed by means of a Time Limited Ageing Analysis (TLAA).

Individual AMPs clearly state what degradation mechanism they intend to manage. Where different mechanisms require similar ageing management activities, they may be grouped into collective AMPs, as in this case for the steam generator tube bundle.

Visualizing AMPs by means of the mechanism matrix is applicable for both individual structures and/or components and for commodity groups.

Benefits

The use of the 'Mechanism Matrix' enables the plant to easily verify that any degradation mechanism is adequately managed at all relevant locations in the plant, thus contributing to the safe operation during Long Term Operation. The overview of the mechanism matrix provides the following benefits:

- Verification that all relevant AMPs have been identified, ensuring efficient use of available resources for the maintenance of the plant-level ageing management programme;
- Verification that any multidisciplinary ageing management activities are adequately captured in AMPs, coordinated by ageing management working groups from across the organization;
- Possibility of benchmarking against International Generic Ageing Lessons Learned AMPs, ensuring that proven practices in the nuclear industry are considered in the plant's ageing management programme;
- Efficient verification of the application of lessons learned from operating experience or research & development results and introducing them into the plant's own AMPs.

The mechanism matrix contributed to significant improvement in the coordination and traceability of the plant's ageing management activities since implementation of the plant-level ageing management programme.

6. OPERATING EXPERIENCE FEEDBACK

6.2. THE MANAGEMENT SYSTEM AND THE ROLE OF MANAGEMENT

The plant had implemented an integrated deviation and good practice reporting information system, known as ‘TAS Helix’, with a user-friendly interface. All personnel at the plant had been informed about the expectations for the identification and reporting of low-level events on TAS Helix through a promotion campaign. This campaign also used water bottle labels to further promote the use of the ‘TAS Helix’ system. In addition, ‘Basic Expectations’ cards were included on their site pass lanyards, with one of the expectations stating that ‘We work together, share knowledge and experience and stimulate improvement.’ These were recognized as a good performance.

6.5. INVESTIGATION

The plant developed a ‘Human Performance Report’ form to record personal experiences, observations and findings in a timely manner directly from all personnel who have been involved in a human performance related event. Because this form is available in Dutch, English and German, third parties engaged in plant outage are also able to fill in. The plant held improvement sessions named ‘Kaizen’ by applying data-driven six sigma approaches, including the five-time ‘WHY’ question method to investigate the event for root cause identification. ‘Kaizen’ sessions also contribute the plant’s continuous improvement with the plan-do-check-act (PDCA) cycle. The team recognized this as a good performance.

6.7. CORRECTIVE ACTIONS

There are no written criteria of the expectation in regards of reporting the actions arising from the self-assessment reports in the corrective action programme (CAP) database. There are no clear criteria in the performance indicator procedure when the actions arising from failure to meet key performance indicator (KPI) targets have to be reported to the CAP database. A procedure states that the process owner has to take actions to achieve the targets but there is no requirement for actions to always be put into the CAP system. The team encouraged the plant to define clear written criteria in their procedures.

DETAILED OPERATING EXPERIENCE FEEDBACK FINDINGS

NONE

7. RADIATION PROTECTION

7.3. RADIATION WORK CONTROL

Field observations and document reviews identified weaknesses in radiation practices. Field practices for contamination control did not identify and address all contamination risks, for example, the floor contamination was not checked prior to opening the radiological controlled area (RCA) (air lock and hatch) for releasing material. Mismatches were also identified in some Radiological Work Permits (RWP), and consequent independent review of high risk RWP was not ensured. Despite the regular inventory of radioactive sources stores, the review revealed non-labelled, non-identified and non-recorded sources. The team made a recommendation in this area.

There was a lack of rigour when addressing improper behaviours and resolving radiological field deficiencies. Shortfalls identified by the plant were not always corrected in a timely manner. For example, defects were found in radiological measurement equipment and there were examples of overdue corrective actions. Dose rate alarms and the personal contamination events were recorded but not reported on a regular basis to the respective department heads and there were examples of inappropriately labelled radioactive waste. The team made a recommendation in this area.

The plant developed a tool for visualization of the Radiologically Controlled Area (RCA). It consists of a complete set of 3D images of every single room of the RCA, including the components, and the images are updated when there is a modification in the room or on the equipment. The tool has a user-friendly Graphical User Interface (GUI) and is used on regular basis for work preparation by operations, maintenance, radiation protection and engineering departments. Consequently, the number of on-site visits in the RCA is reduced, and hence optimize radiation dose and working time, and increasing the quality of work preparation. The team recognized this as a good performance.

7.4.CONTROL OF OCCUPATIONAL EXPOSURE

The plant developed an ultrasonic-based tool for distance measurements when performing radiation measurements. For some tasks, for example, the formal release of fuel containers and waste containers, it is essential to perform radiation measurements at a predefined distance. Indicating the distance with color LEDs, the tool enables the workers to measure the exact distance that is required. The tool being constructed by a 3D printed design, is inexpensive. Furthermore, it can be easily adapted on every radiation measurement device needed. The team recognized this as a good performance.

DETAILED RADIATION PROTECTION FINDINGS

7.3 RADIATION WORK CONTROL

7.3(1) Issue: The plant radiation protection practices for the contamination control, dose planning and the control of radioactive sources, do not always ensure that the requirements of the radiation protection programme are met.

During the review the team noted:

- For the dose rate measurements on waste drums, the Radiation Work Permit (RWP), 'WO 122191-01', both predicted and confirmed an area dose rate higher than 50 µSv/h. However, the area dose rate according to the door labelling and the workplace monitoring was 1 µSv/h, i.e., a mismatch of factor 50. Furthermore, the workers would have exceeded their RWP-confirmed daily dose limit of 50 µSv in one hour, but they were planned to work several hours on the workspace each day.
- When reviewing high risk RWPs, during normal operation, there was no plant expectation for an independent review of high risk RWPs and the corresponding risk assessments.
- When reviewing 10 high risk RWPs (random selection, starting after the week 29, 2022), in approximately 50% of RWPs reviewed, mismatches or deviations were identified (mainly in the RWPs for normal operation). For example, the risk assessment identified airborne contamination and activity, but the respective counter measures were not selected (WO 114930-03). Another example, the risk assessment stated an area dose rate lower than 50 µSv/h, in contradiction to the workplace monitoring record requesting an on-site measurement because of high and/or changing dose rate (WO 117160-01).
- When leaving the Radiological Controlled Area (RCA) for a coffee break, the workers and the radiation protection (RP) technician did not close the main door to a radioactive store. The additional shield was closed, however, the sign 'radioactive storage' on the main door stated the expectation to close the main door whenever work is paused or finished.
- While performing contamination measurement, a RP technician put the 'CoMo' (handheld contamination monitor) directly on the potentially contaminated surface and near the items to be checked for contamination.
- There is no plant expectation to check floor contamination prior to releasing material from the RCA (air lock and hatch). Consequently, the RP technician did not check the floor nor the tyres when a forklift truck from outside drove in and out to release material from the RCA.
- There is no plant expectation to perform a function test before using the 'CoMo' (handheld contamination monitors), and no respective check sources were available. For example, some 'CoMo' for releasing material from the RCA were used on an irregular basis only and consequently had an enhanced risk of unidentified malfunction.
- 37% of the personal contamination events in the year 2022 were caused by Monitoring Staff (RP, Chemistry, Radwaste).
- In both radioactive source stores reviewed, several shortfalls were revealed. For example, in room 03.403 (hot lab):

  - three non-labelled, non-identified and non-recorded liquid sources;
  - liquid sources without official identification labels (handwritten or missing, sources), sources that are supposed to be disposed (inventory list) in 2011 were still in the source store;
  - five not completely recorded source movements since April 2022 (source out, but no source in);
  - source box repaired with tape.

- When faced with a non-labelled, non-identified and non-recorded solid radioactive source in the source store, the RP technician did not perform an immediate radiation measurement to exclude radiological risks and to protect the five workers in the room.
- In the last two years, the plant had five events where contamination or radioactive material was found outside the RCA. This included shipping a contaminated pressurizer component to a radiologically non-licensed supplier in France (July 2022).
- In 11 out of 13 events directly related to Radiation Protection (RP) in the last 24 months, the plant Operating Experience (OE) identified the causes as not following basic RP rules, non-adherence to plant procedures and lack of questioning attitude. For example, there were two internal contaminations in the 2021 outage.

Without robust radiation protection practices the plant may not succeed in reducing contamination events, preventing the daily dose limits being exceeded and ensure full control and accountability of the radioactive sources.

Recommendation: The plant should strengthen the radiation protection practices for contamination control, dose planning and the control of radioactive sources to ensure that the requirements of the radiation protection programme are fully met.

IAEA Bases:

SSR-2/2 (Rev. 1)
Requirement 20: Radiation protection
The operating organization shall establish and implement a radiation protection programme.

5.10. The operating organization shall ensure that the radiation protection programme is in compliance with the requirements of Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards (No. GSR Part 3) [8]. The operating organization shall verify … that the radiation protection programme is being properly implemented and that its objectives are being met.

5.13. All plant personnel shall understand and acknowledge their individual responsibility for putting into practice the measures for controlling exposures that are specified in the radiation protection programme.

GSR Part 3
Requirement 22: Compliance by workers
Workers shall fulfil their obligations and carry out their duties for protection and safety.

3.83. Workers:

(a) Shall follow any applicable rules and procedures for protection and safety as specified by the employer, registrant or licensee;
(b) Shall use properly the monitoring equipment and personal protective equipment provided;
GSG-7
2.10. In planned exposure situations, in relation to exposures due to any particular source within a practice, protection and safety is required to be optimized in order that the magnitude of individual doses, the number of people exposed and the likelihood of incurring exposures all be kept as low as reasonably achievable, economic and societal factors being taken into account, with the restriction that the doses to individuals delivered by the source be subject to dose constraints.

Plant Response/Action:

Cause:
The Radiation Protection (RP) department has had in recent years a lot of changes in personnel and team leader positions. Besides, the collaboration within the team was an issue. Because of that, work practice standards have declined.

Actions Performed:
In 2023 and 2024 RP professionals from INPO and WANO visited the Borssele NPP and discussed with RP management the issues and improvement areas.
In 2023 a new RP department manager was appointed, and vacancies in the RP department are filled.
In 2023, an action plan called 'Radiation protection to excellence' was developed to solve both OSART recommendations and to move towards excellence in RP. Five improvement areas are developed. The improvement areas are:
– Standards and expectations are not used actively
– There was insufficient focus on RP excellence
– Radiation safety has little attention in the organization
– Understaffing in the RP department
– Delayed maintenance and replacement of RP instruments.

These areas are worked out in detailed actions. The action plan runs from 2023 to the end of 2025.
Some examples of implemented actions are:
– The use of standards and expectations has been reinforced (on the agenda at the daily morning meeting); the standards are visible communicated at the entrance of the controlled area, and in the standard format for power point presentations.
– The RP team is trained in ownership, and further developed in collaboration, identifying deviations and solving issues (more low-level events and near misses are reported by RP personnel). Teambuilding is started and promoted collaboration within the RP team.
– The ALARA committee has been reinforced and is now chaired by the Plant Manager. Practical items are discussed in the committee, and all operational departments deliver members for the committee.
– LIF checklists on RP department, and on Working in the controlled area are developed and implemented. The first insights are used to strengthen further the RP practices.
– The electric learning environment on Working in the controlled area is developed and rolled out through organization. This is an obligatory training course for all nuclear workers.
– Training Radiation Risks for supervisors and managers is developed and given in 2024.

Results and Effectiveness:
Although the improvement plan is still running, and the strive for excellence will never end, improvements are already visible:
- RP work practice has improved
- The control of dose is improved (less daily dose exceedances)
- Contamination control is improved
- Oversight by RP is improved, RP personnel act more as oversight, and less as facilitator
- RWP have now a better quality.
- Control of radioactive sources is improved.

IAEA comments:
The plant carried out a causal analysis which identified a decline in radiation protection practices due to changes in personnel and insufficient reinforcement of expected standards.

The plant identified several actions aligned to the plant’s drive for continuous improvement. These actions included the updating of the radiation protection (RP) roadmap towards excellence, the establishment of controlled area safety rules and expectations and RP technicians having a more prominent oversight role in the planning and execution of RP related work activities. The plant also carried out benchmarking activities with representatives from INPO, Doel NPP and WANO. In addition, a new e-learning course on ‘Working in the Controlled Area’ was developed in 2024, outage booklets containing relevant RP information have been produced for all the outages completed since the original OSART mission and working times for the wearing of RP protective equipment have been defined.

Independent reviews of high-risk radiation work permits (RWPs) are now carried out and RWPs are completed digitally with automatic inclusion of the latest dose and contamination measurements from the biannual routine surveys. The development of the digital RWPs was undertaken by a member of the RP department.

Source store controls have improved following a review of the contents of the radioactive stores in 2023 and regular compliance checks are also now carried out by RP technicians. A check on two of the source stores located in the RCA did not identify any discrepancies. In addition, RP instrument check sources have been installed adjacent to the RP offices inside the RCA, to enable daily checks of RP instrumentation to be carried out.

The plant developed two additional on-the-job training (OTJ) training courses, covering topics such as: use of contamination monitors, measurement of doses and release of materials from the RCA. In addition, RP procedures have been updated to include checks on floor contamination prior to releasing material from the RCA and the plant now holds an annual RP teambuilding and training day.

Since 2023, independent oversight reviews of RWPs have only reported minor deviations in the completion of the document and there have been no events raised with incomplete RWPs as causal factors. In addition, there have been no events raised due to improper storage of radioactive sources.

However, the plant had five contamination control related events since the original OSART mission. Three of these events required a root cause analysis and the other two required an apparent cause analysis. Furthermore, two of the events were associated with contamination detected outside of the RCA (event number 5554 – April 2025 and event number 1553 April 2023).

Conclusion: Satisfactory progress to date.

7.3(2) Issue: The plant arrangements for addressing improper behaviours and resolving radiological field deficiencies do not always ensure that the deficiencies are addressed in a timely manner.

During the review the team noted:

- A handheld dose rate meter (teletector) for daily use was found in a partially degraded condition. Two days after notification, no action had been taken and the specific teletector was still in use.
- At the time of the review, 13 out of 43 teletectors were out of order. These shortfalls were not consistently reported. As consequence, neither the Monitoring Department Head nor the Senior Radiation Protection (RP) staff was aware of these shortfalls.
- Some deviations in the radioactive source stores were identified in December 2022 while performing a regular inventory control, and corrective actions were proposed. Two RP technicians were assigned to provide independent verification of the inventory control and proposed actions. However, this review revealed that the plant failed to take action.
- In room 03.208, three out of 16 boxes with radioactive or contaminated material were not labelled according to plant expectations (stickers with missing dates, missing contamination levels). In the neighbouring room, there were three bags with only handwritten contamination level, and none of the bags in the room had the required official stickers attached. These shortfalls had existed for at least one year.
- Despite the Maintenance Department causing 54% of the personal contamination events in the year 2022 and 48% in 2021 (high percentage), no RP refresher training or RP On-the-Job-Training (OJT) was planned for maintenance personnel.
- The two most significant Leader-in-the-Field (LiF) categories (human performance, health and safety) do not include any radiological criteria or items to be observed. Furthermore, the quarterly LiF report to the plant management did not include any radiological aspects.
- The dose rate alarms and the personal contamination events were recorded but not reported on a regular basis to the respective department heads or to the senior management team. As consequence, department heads were not fully aware of the radiological performance of their staff.
- It was common practice to tape the loudspeaker of the handheld dose rate meters (teletectors) because the acoustic alarm was perceived as too loud. This unofficial modification of safety-related measurement devices was neither addressed by the line supervision nor by the Leader-in-the-Field (LiF) programme.
- Despite significant radiological events during the 2021 outage, the plant did not set or adjust the LiF expectations in order to reinforce radiological expectations or to assess effectiveness of the actions.
- Since April 2021, 78 Radiation Protection related actions have been issued in the Corrective Action Programme (CAP). At the time of the review (end of January 2023), 15 out of 78 these actions were overdue, even when taking into consideration approved extensions. For example, the action 352.01 related to the significant radiological events during the 2021 outage was going to be extended for the fourth time.

– Radiation Protection had been escalated by the Independent Nuclear Oversight department twice in four recent years as a result of performance issues including insufficient adherence to standards and a lack of response to identified gaps.

Without robust arrangements for addressing improper behaviours and resolving radiological field deficiencies, the plant may be faced with repeated radiological events or degraded radiological performance.

Recommendation: The plant should enhance the arrangements for addressing improper behaviours and resolving radiological field deficiencies in order to ensure that the deficiencies are addressed in a timely manner.

IAEA Bases:

SSR-2/2 (Rev. 1)
Requirement 20: Radiation protection
The operating organization shall establish and implement a radiation protection programme.

5.10. The operating organization shall ensure that the radiation protection programme is in compliance with the requirements of Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards (No. GSR Part 3) [8]. The operating organization shall verify … that the radiation protection programme is being properly implemented and that its objectives are being met.

GSR Part 3
Requirement 5: Management for protection and safety
2.47. The principal parties shall demonstrate commitment to protection and safety at the highest levels within the organizations for which they are responsible.
2.48. The principal parties shall ensure that the management system is designed and applied to enhance protection and safety by:
(b) Describing the planned and systematic actions necessary to provide adequate confidence that the requirements for protection and safety are fulfilled;
(d) Providing for the regular assessment of performance for protection and safety, and the application of lessons learned from experience

GSR Part 3
Requirement 22: Compliance by workers
3.84. A worker who identifies circumstances that could adversely affect protection and safety shall report such circumstances to the employer, registrant or licensee as soon as possible

Plant Response/Action:(same as 7.3(1)

Cause:
The RP department has had in recent years a lot of changes in personnel and team leader positions. Besides, the collaboration within the team was an issue. Because of that, work practice standards have declined, and inappropriate behaviors occurred.

Actions Performed:
In 2023 and 2024 RP professionals from INPO and WANO visited the Borssele NPP and discussed with RP management the issues and improvement areas.

In 2023 a new RP department manager was appointed, and vacancies in the RP department are filled.
In 2023, an action plan called 'Radiation protection to excellence' was developed to solve both OSART recommendations and to move towards excellence in RP. Five improvement areas are developed. The improvement areas are:
- Standards and expectations are not used actively
- There was insufficient focus on RP excellence
- Radiation safety has little attention in the organization
- Understaffing in the RP department
- Delayed maintenance and replacement of RP instruments.

These areas are worked out in detailed actions. The action plan runs from 2023 to the end of 2025.
Some examples of implemented actions are:
- The use of standards and expectations has been reinforced (on the agenda at the daily morning meeting); the standards are visible communicated at the entrance of the controlled area, and in the standard format for power point presentations.
- the RP team is trained in ownership, and further developed in collaboration, identifying deviations and solving issues (more low-level events and near misses are reported by RP personnel)
- RP instruments are repaired and maintained properly.
- LIF checklists on RP department, and on Working in the controlled area are developed and implemented.
- The electric learning environment on Working in the controlled area is developed and rolled out through organization.

Results and Effectiveness:
Although the improvement plan is still running, and the move towards to excellence will never end, some improvements are already visible:
- RP work practice has improved
- The control of dose is improved (less daily dose exceedances)
- Contamination control is improved
- Oversight by RP is improved, RP personnel act more as oversight, and less as facilitator
- Less human performance events
- Strong improvement in respecting the daily dose limit.

IAEA comments:

The plant carried out a causal analysis and identified that the decline in addressing inappropriate Radiation Protection (RP) behaviours and the delays in resolving radiological field deficiencies was due to insufficient reinforcement of expected behaviours and insufficient collaboration between team members.

The plant improved the controls for the reporting and repair of defective RP instrumentation and at the time of the OSART Follow-up mission there were only five RP instruments awaiting repair. The plant had developed an OJT on the correct use of RP instrumentation and the training course had been completed by all RP technicians apart from one person who was on paternity leave. During a walkdown inside the RCA, no defective RP instruments were observed. In addition, new smaller contamination monitors had been purchased, a new vehicle monitor had been installed at the gate exit and a new laundry monitor was installed in 2024. The plant had also installed a new dosimeter system and made these new dosimeters available in the emergency bunker and in the waste storage buildings.

The plant had gradually reduced the number of overdue RP CAP actions to three (out of a total of 19 actions) and these overdue actions were undergoing further evaluations to set more realistic target dates.

The plant had reinforced RP standards through the adoption of a focused Leader-in-the-Field (LIF) checklist, which specifically targeted compliance of RP personnel with RP standards and expectations. The results of these LIF observations showed a score of 97% compliance for 2024 and 92% compliance in the first quarter of 2025. Furthermore, there was a decreasing trend of non-conformities identified by independent oversight from 11 in 2023 to just one in 2025. This remaining action was associated with the completion of the remaining actions in the D1 and D3 parts of the RP ‘On the Way to Excellence Plan’ and were expected to be completed by the end of 2025. In addition, since the OSART mission there had been no escalation of RP related issues by independent oversight.

There had been no instances of individuals exceeding the daily dose limit in 2024 or during the first quarter of 2025. The maximum individual dose for both contractors and plant personnel over a rolling 5-year period was 3 mSv per year and this had not been exceeded by either contractors or plant personnel.

The plant tracked the number of human performance related events occurring during outages across each of the departments. In 2023, the RP department had three such events, seven in 2024 and zero in the 2025 outage.

Conclusion: Issue resolved

8. CHEMISTRY

8.2. CHEMISTRY PROGRAMME

The plant had established a comprehensive programme for secondary circuit water chemistry control. Activities have been performed to minimize the amount of impurities in steam generators feed water and blowdowns and to reduce corrosion processes in the steam generators. This comprehensive programme for secondary circuit water chemistry significantly supported the reliable operation of steam generators. The team recognizes this as a good performance.

The plant had established a programme for primary water chemistry control. However, it did not include monitoring some chemical parameters that could have an adverse impact on fuel cladding or materials of the primary circuit. The team encouraged the plant to monitor additional parameters, such as aluminum, calcium, nitrates and suspended corrosion products, to avoid potentially adverse effects on the safety systems.

8.4. CHEMISTRY SURVEILLANCE AND CONTROL PROGRAMME

The plant used the ratio between concentration of hydrazine in the steam generator feed water and the blowdown as an additional information to evaluate the amount of sludge inside the steam generator. In addition, long-term trending and evaluation of hydrazine ratio was used as a supplementary indicator to perform chemical cleaning of the steam generator. The team recognized this as good practice.

8.5. LABORATORIES AND MEASUREMENTS

The plant performed sampling of radioactive primary water in a box equipped with a remotely controlled cart to transport sample bottles from the sampling section to the manipulating section. Moreover, a shower to rinse the bottles with demineralized water was placed between these sections and was controlled remotely. The main benefits of working in this sampling box were the minimization of radiation doses and risk of contamination. In addition, the glove box allowed the sampling to be performed in the conventional manner. The team recognized this as a good performance.

The plant had set up a programme for identification, labelling, storage and use of chemicals. However, the team observed examples where work and laboratory practices did not follow this programme, such as unlabeled bottles, missing information about chemicals shelf life or shortcomings in sampling and performing analyses. The team made a suggestion in this area.

DETAILED CHEMISTRY FINDINGS

8.4. CHEMISTRY SURVEILLANCE AND CONTROL PROGRAMME

8.4(a) Good practice: The plant uses the hydrazine concentration ratio as an additional indicator to evaluate the amount of sludge inside the steam generator.

Purpose

The difference in measured concentrations of hydrazine between the steam generator feed water and the blowdown can be used as a supplementary indicator for the evaluation of the condition concerning the steam generators.

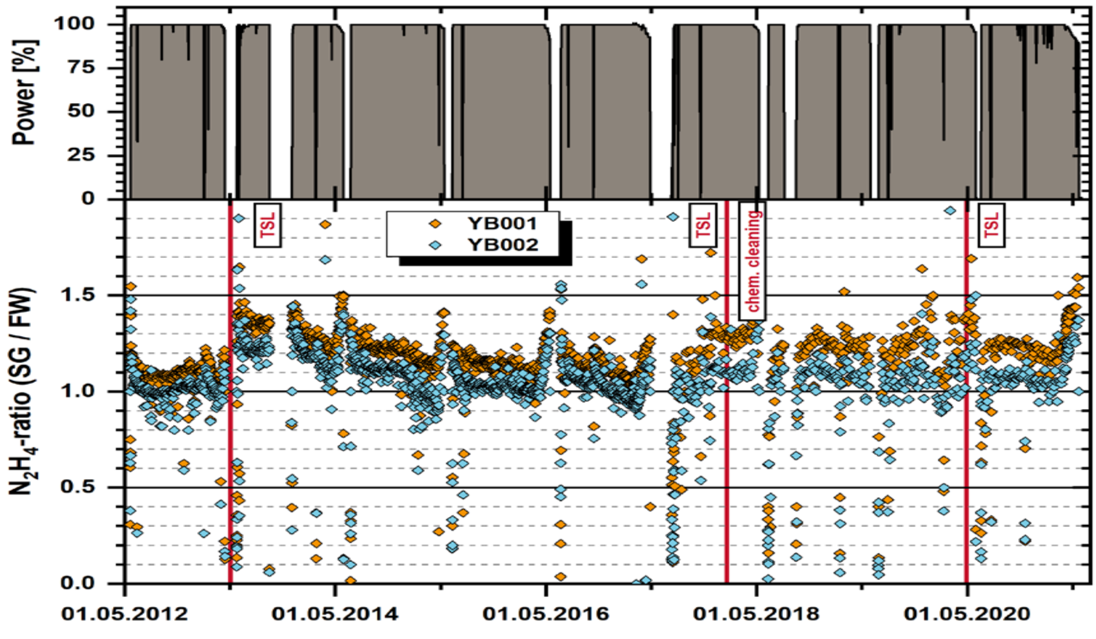
Description

The hydrazine concentration in the steam generator decreases in time due to the decomposition of hydrazine to ammonia and nitrogen. This decomposition is enhanced by catalytically active surfaces, such as magnetite deposits in the steam generator. Based on this knowledge the plant introduced an indicator based on the ratio between concentration of hydrazine in the steam generator feed water and the blowdown (hydrazine ratio). According to the plant experience during operation, this indicator could decrease from approximately 2.0 (for a clean steam generator) to 0.5 (for a steam generator containing significant amount of sludge).

The hydrazine ratio is used as supplementary information to perform chemical cleaning of the steam generator (for example, in 2004 the hydrazine ratio decreased to 0.5, this supported the decision to perform chemical cleaning of the steam generator).

The real data are shown in the figure, as follows:

- An increase of hydrazine ratio in the operating cycle after the mechanical tube sheet lancing in April 2013 (indication of a significant decrease of corrosion products in steam generators).
- An increase of hydrazine ratio after the chemical-mechanical tube sheet cleaning in May 2017.
- An increase of the hydrazine ratio after the mechanical tube sheet cleaning in June 2019 and April 2022 inspection.



Long-term monitoring of hydrazine ratio

Benefits

Long-term monitoring of hydrazine ratio is an easy performance indicator for:

- Evaluation of the amount of the sludge in the steam generator during the cycle.
- Evaluation of necessity to perform mechanical or chemical cleaning of the steam generator.

8.5(1) Issue: The implementation of some of the plant's chemical control practices are not always optimised to ensure correct identification, labelling, storage and use of chemicals as well as accurate results of chemical analyses.

During the review, the team noted the following:

Chemical identification and labelling:

- Three bottles without any label were placed inside cabinet VF005A001 of the conventional emergency cooling water system.
- Unlabelled container for radioactive sample was placed in the back-up systems bunker (building No. 33).
- Unlabelled flasks with chemical solutions were stored in conventional chemical laboratory.
- Labelling of sample bottles in nuclear laboratory was not consistent. Some bottles were not labelled but named with a marker.
- Barrel placed in the warehouse (building No. 60) for hazardous chemicals was not labelled. When asked what was inside, the warehouse manager explained that de-icing salt was stored there.
- The bottle containing solution for sodium electrode calibration was labelled with the information about the date of preparation (3 June 2022), but there was no information about the expiry date or confirmation that the solution can be used until it is all used up.

Chemical storage:

- 20-liter canister containing the additive for diesel fuel placed in the warehouse (building No. 60) was labelled without information about its shelf life.
- 10 bottles with sodium hydroxide were stored in the chemical storage, but only nine bottles were recorded in the registration system at that time.
- There was corrosion damage in some spots in the inner space of cabinet for storing of chemicals for analytical purposes in nuclear laboratory.

Laboratory practices:

- The chemical nuclear laboratory was not equipped with back-up device for measurement of chlorides in primary circuit water in the case that the ion chromatograph did not work.
- According to the procedure for evaluation of check standards within the quality assurance programme, analyses should not be performed when the value for check standard is out of permitted range. This requirement was not fulfilled for measurement of magnesium in primary circuit on 14 November 2022 when the analysis was performed, as the concentration of magnesium in the check standard was out of the permitted range.
- No check standard was used for analysis of total organic carbon (TOC) concentration.
- The use of gloves was required only for taking of radioactive samples or samples containing higher concentration of hydrazine. In other cases, sampling could be done without using gloves. According to the plant experience and laboratory results there was no difference between sampling with gloves and with bare hands related to the risk of sample contamination. However, no benchmarking or risk analysis was performed to

prove that there was no risk of sample contamination, when the sampling was done without gloves.

– Chemistry personnel did not provide training for operational staff on how to correctly take samples from safety-related systems for chemical analyses.
– There was a damaged frame on the emergency sampling installation TV062B002 in the back-up systems bunker (building No. 33).
– The side glass wall of fume hood used in conventional laboratory was partially cracked.

Without proper application of work practices for identification, labelling, storage and handling of chemicals, plant equipment and personnel safety as well as quality of measurement could be compromised.

Suggestion: The plant should consider enhancing its implementation of chemical control practices to ensure appropriate identification, labelling, storage and safe handling of chemicals as well as accurate results of chemical analyses.

IAEA Bases:

SSR–2/2 (Rev.1)

7.15. The chemistry programme shall include chemistry monitoring and data acquisition systems. These systems, together with laboratory analyses, shall provide accurate measuring and recording of chemistry data and shall provide alarms for relevant chemistry parameters…

7.17. The use of chemicals in the plant, including chemicals brought in by contractors, shall be kept under close control. The appropriate control measures shall be put in place to ensure that the use of chemical substances and reagents does not adversely affect equipment or lead to its degradation

SSG-13

6.12. Reagents and sources used for calibration should be valid (e.g. all standards applied should be traceable to certified standard solutions or reagents).

6.18. 'Check standards' (measurements made at specified time intervals) should be analysed and control charts should be maintained to show that the methods applied continue to give accurate results.

6.31. Redundancy or equivalency of laboratory facilities should be provided to ensure analytical services at all times.

6.32. Laboratories should have good general housekeeping, orderliness and cleanness at working areas and sampling points, including satisfying appropriate contamination level criteria, in accordance with procedures at the plant.

6.33. Industrial safety (provision of fume hoods for ventilation, appropriate storage of flammable solvents and hazardous materials, and flammable and other gases, and provision of safety showers for personnel, as well as personal protective equipment and first aid kits) and radiological safety (proper radiation shielding and contamination control facilities) should be ensured.

6.36. Adequately redundant instrumentation and equipment for performing analyses of given types and frequency should be made available…

6.40. If instrument performance shows significant deviation from expected values, an investigation should be performed to determine the cause of the deviation. Repair or recalibration of an analytical instrument may be necessary to maintain or recover the desired level of accuracy

6.42. Representative grab samples should be ensured by appropriate flushing of sampling lines, proper determination of the flow rate, cleanness of containers, and minimization of the risk of chemical contamination and loss of dissolved gases or volatile substances during sampling…

9.9. Chemicals and substances should be labelled according to the area in which they are permitted to be used, so that they can be clearly identified. The label should indicate the shelf life of the material.

9.10. When a chemical is transferred from a stock container to a smaller container, the latter should be labelled with the name of the chemical, the date of transfer and pictograms to indicate the risk and application area.

Plant Response/Action:

Cause:
Chemicals are used throughout the organization. There was no clear standard for labelling and controlling these chemical products.

Actions Performed
A new standard has been adopted for labelling chemical products. The software tool from a specialist chemical labelling company has been adapted and implemented. Until today, 400 chemicals have been embedded in the new software environment. This standard is rolled out throughout the organization.

The quality control programme of the chemical department has been improved. The two chemical engineers perform a review of the laboratory activities and report monthly to the department manager.

Results and Effectiveness:
More and more chemicals are labelled according to the new standard. At several places in the installation, printers are available for printing the new labels.

Laboratory work practices are improved, and there are less deviations in the results of chemical analysis and calibrations.

IAEA comments:

The plant analyzed the issue and found that the direct cause was due to a lack of a plant standard for the labelling and storage of chemicals and inconsistencies in chemical laboratory practices. The plant set up a number of actions to address the deficiencies identified in the labelling, storage and safe handling of chemicals and to enhance the implementation of chemical control practices. These included the procurement of a specific software tool, which stores and allows easy access to all the chemical Material Safety Data Sheets (MSDS). It also enabled the printing of chemical labels detailing the EU-approved pictograms, main chemical hazardous properties and, as appropriate, allows a warning to be included on the label detailing any restrictions where the chemical should not be used (for example, ‘this chemical should not be used in the nuclear island’). The label also allowed a chemical expiry date to be added, if appropriate.

The software tool was linked to the chemical procurement process, so that for any new chemicals not currently used on the site, the MSDS was added into the software system before the chemical was brought to the site and used. At the time of the OSART Follow-up mission, there were 470 chemicals registered within the specific software tool and the plant was awaiting the MSDS from the supplier for 3 chemicals used during the decontamination process. Once these remaining MSDS were received, the specific software tool then contained all the required chemical information for all chemicals procured within the past five years.

The specific software tool was populated with all the site chemical MSDS in January 2025 and the associated procedures; Procedure for Chemical Labelling (N04-28-037) and Procedure for Requesting and Registering Hazardous Chemicals (PU-A09-105-002) were updated in March 2025. A communications plan was also launched in early 2025 and the 6-monthly refresher training for operations personnel updated to include the new arrangements. The plant had also developed an e-learning course on the Labelling of Hazardous Products which was expected to be rolled out to all site personnel in June 2025.

A review of the procedures for chemical labelling and requesting and registering hazardous chemicals confirmed that the arrangements were in place and a visit to the conventional chemical laboratory, conventional chemical storage area and the nuclear chemical laboratory, found that the chemicals were labelled in accordance with these procedures apart from two minor discrepancies in the nuclear laboratory. Printers for the labelling of chemicals were placed at seven locations, such as in the maintenance and civil workshops as well as in the conventional and nuclear chemical laboratories.

The plant was in the process of procuring an inductively coupled plasma mass spectrometer (ICP-MS) which included the function for the measurement of chlorides in the primary circuit and had updated the procedure for the daily use of a check standard when carrying out the analysis of total organic carbon concentration. The plant undertook an analysis which confirmed that there was no risk of secondary water sample contamination from the non-wearing of gloves by chemistry personnel. On-the-job training on sample taking from safety-related systems had been delivered to all field operators and the damage to the sampling installation (TV062B002) was repaired in May 2023 and all the fume hoods in the conventional chemical laboratory were replaced as part of the total refurbishment of the laboratory which was completed in January 2024.

Conclusion: Issue resolved

9. EMERGENCY PREPAREDNESS AND RESPONSE

9.2. EMERGENCY RESPONSE

The plant had established a protection strategy and procedures related to on-site and off-site implementation of protective actions in case of emergency. However, during the review the team noted some shortcomings. The plant provisions for protective actions in case of emergency do not always ensure timely and efficient emergency response. For example, no permanent dose rate measurements were at the muster points of buildings 58 and 57. The main storage was designed for 2200 iodine prophylaxis (according to procedure N14-26-015), however, there were only 680 iodine tablets stored with a valid expiry date. The plant had not carried out an emergency exercise involving the personal decontamination process within the emergency control centre. The team made a suggestion in this area.

9.3. EMERGENCY PREPAREDNESS

The emergency plan was divided in several sub plans. There was no single emergency plan that describes the objectives, policy and concept of operations for the response to an emergency and the structure, authorities and responsibilities, to serve as the basis for the development of other plans, procedures and checklists. In total, there were more than 200 emergency preparedness regulations, which can lead to inconsistencies and unclear deployment of emergency response actions. The team encouraged the plant to improve the documentation related to emergency preparedness and response.

The muster point No.15 221 is an area, which is designed for evacuated personnel from the radiological control area who could be potentially contaminated, to be separated from others. Therefore, there is a changing room, mobile barriers installed to separate this muster point and can be expanded as needed. The team recognized the purpose and the above-mentioned arrangement of this muster point as a good performance.

During the last three years, the required training, drills and exercises for each emergency response organization (ERO) role was evaluated, which lead to improved and increased requirements for ERO qualified personnel. For the integral exercises, self-assessment forms for each role of the ERO were performed, used and then independently checked. The introduction of the above activities helped to significantly improve the participation rate of ERO members on trainings, drills and exercises from 79% in 2018 to 96% at the end of 2022. The team recognized this as good performance.

The preparedness of the plant emergency facilities, equipment, and documentation is not comprehensive enough to ensure effectiveness of the ERO. For example, in the emergency control centre (ECC) there is no automatic system to monitor the radiation situation inside. Oxygen and carbon dioxide measurements are not placed within this centre itself. The Back-up of ECC in Middelburg town, was equipped with 26 filters, and all of them had an expiry date of 1 February 2023 which was the same date of the visit. The team made a suggestion in this area.

DETAILED EMERGENCY PREPAREDNESS AND RESPONSE FINDINGS

9.2.EMERGENCY RESPONSE

9.2.(1) Issue: The plant provisions for protective actions in case of an emergency do not always ensure timely and efficient emergency response.

During the review the team noted:

- At the muster point of building No.15 there is a permanent dose rate measurement. However, there are no permanent dose rate measurements at the muster points of buildings 58 and 57.
- There was no instruction to inform employees that they must record their presence at the muster point using the ‘green’ pass readers.
- According to procedure N14-26-015 entrance building No.14 was the main storage for 2200 iodine prophylaxis. However, only 680 iodine tablets with valid expiration dates were stored there. The rest of the iodine tablets was stored at other locations and were not registered in the inventory list of that procedure.
- In the storage room of the canteen No.15 (Muster point) 2400 iodine tablets were found with the expiration date of November 2021.
- The facility manager (MOD), member of the emergency control centre, had a duty in the distribution of iodine prophylaxis tablets. However, this task was not described in the working document ‘actions for the MOD’ (N14-23-200).
- There was no procedure or instruction for the emergency response organization members to go directly from home to the back-up emergency response centre in Middelburg town, if the on-site emergency control centre was uninhabitable due, for example, to a plane crash.
- In the emergency control centre, there were only 50 iodine tablets stored which was insufficient for events spanning several days.
- At the entrance building No.14, respirator masks were available for security personnel. However, other protective equipment, such as a protective suit, overalls and gloves, were not placed at the entrance building.
- The plant had not carried out an emergency exercise involving the personal decontamination process within the emergency control centre. Furthermore, the plant had not carried out an emergency exercise involving the deterioration of oxygen or radiation conditions in the emergency control centre to check the shelter habitability conditions.
- No iodine tablets were stored at main control room, fire station and at the backup of the emergency control centre in Middelburg town.
- At Muster point No.15 221 (designed for evacuated personnel from the control zone):
  - The instruction N14-25-103 required the installation of a barrier for visible separation of the contaminated area, was not placed at the muster point.
  - A portable radiation measuring device was not in place to meet the requirement to measure potentially contaminated persons.
  - There is no protective equipment for radiation technicians making measurements of potentially contaminated person at this muster point. Neither in the regulation N14-26-012 / N14-25-103 nor in the inventory sheet (on the cupboard) was there a requirement to specify the type and quantity of protective equipment intended for radiation technicians to carry out these measurements.

Without the effective implementation of protective actions, the health of persons as well as the emergency response organization (ERO) staffing capacity might be compromised in the event of an emergency.

Suggestion: The plant should consider improving the plant provisions for protective actions in case of an emergency to ensure timely and efficient emergency response.

IAEA Bases:

GSR Part 7

Requirement 9: Taking urgent protective actions and other response actions.

5.37. Arrangements shall be made for actions to save human life or to prevent serious injury to be taken without any delay on the grounds of the possible presence of radioactive material (see paras 5.39 and 5.64). These arrangements shall include providing first responders in an emergency at an unforeseen location with information on the precautions to take in giving first aid or in transporting an individual with possible contamination.

5.41. The operating organization of a facility in category I, II or III shall make arrangements to ensure protection and safety for all persons on the site in a nuclear or radiological emergency. These shall include arrangements to do the following:
(a) To notify all persons on the site of an emergency on the site;
(b) For all persons on the site to take appropriate actions immediately upon notification of an emergency;
(c) To account for those persons on the site and to locate and recover those persons unaccounted for;
(d) To provide immediate first aid;
(e) To take urgent protective actions.

5.42. Arrangements as stated in para. 5.41 shall also include ensuring the provision, for all persons present in the facility and on the site, of:
(a) Suitable assembly points, provided with continuous radiation monitoring;
(b) A sufficient number of suitable escape routes;
(c) Suitable and reliable alarm systems and other means for warning and instructing all persons present under the full range of emergency conditions.

Requirement 11: Protecting emergency workers and helpers in an emergency.

5.52. The operating organization and response organizations shall ensure that arrangements are in place for the protection of emergency workers and protection of helpers in an emergency for the range of anticipated hazardous conditions in which they might have to perform response functions. These arrangements, as a minimum, shall include:
(a) Training those emergency workers designated as such in advance;
(b) Providing emergency workers not designated in advance and helpers in an emergency immediately before the conduct of their specified duties with instructions on how to perform the duties under emergency conditions (‘just in time’ training);
(c) Managing, controlling and recording the doses received;
(d) Provision of appropriate specialized protective equipment and monitoring equipment;
(e) Provision of iodine thyroid blocking, as appropriate, if exposure due to radioactive iodine is possible;

(f) Obtaining informed consent to perform specified duties, when appropriate;
(g) Medical examination, longer term medical actions and psychological counselling, as appropriate.

5.53. The operating organization and response organizations shall ensure that all practicable means are used to minimize exposures of emergency workers and helpers in an emergency in the response to a nuclear or radiological emergency (see para. I.2 of Appendix I), and to optimize their protection.

5.58. Arrangements shall be made to assess as soon as practicable the individual doses received in a response to a nuclear or radiological emergency by emergency workers and helpers in an emergency and, as appropriate, to restrict further exposures in the response to the emergency.

5.61. Information on the doses received in the response to a nuclear or radiological emergency and information on any consequent health risks shall be communicated, as soon as practicable, to emergency workers and to helpers in an emergency.

Plant Response/Action:
The issue is recognized by the plant.

Cause:
Emergency preparation is a cross functional process for which many departments/groups and individuals have responsibilities. Subsequent changes in the organization of emergency preparation (EP), with respect to the responsibility for EP, with respect to the resources dedicated to EP and in the integrated management system have led to the observed deficiencies.

Actions Performed:
A modification plan has been authorized to install dose rate meters at the muster points in buildings 58 and 57. The dose rate meters have been installed; the update of the related IMS documents is in progress.
All unauthorized operator aids have been removed from the emergency response locations.
The N14-26-xxx documents describing the emergency response materials have been checked and the required 6 monthly surveillance is in place.
The procedures have been updated to make it possible to directly order the emergency response staff to go to Middelburg instead of Borssele.
The muster points 15.221 is equipped with a hand-foot monitor that can also be used to check the on-site personnel that work from the ACC, the update of the related IMS documents is in progress.

Results and Effectiveness:
The dose rate meters for the muster points have been installed.
Relevant procedures have been updated and the use of unauthorized operator aids has been strongly reduced. The overall organizational and procedural description of EP is still under development.

IAEA comments:

Cause:
The plant has carefully analysed the issue and identified the following root causes:

- subsequent changes in the organization of the emergency planning and preparedness process, including the assignment of competences and responsibilities for this process, including staff resources, as well as in the integrated management system

- the lack of challenging assumptions about emergency accident scenarios, related to sufficient consideration of effective use of designated facilities, equipment and procedures in case of emergency.

Sufficient staff capacity is needed for this comprehensive approach to emergency preparedness, which should integrate the required emergency response procedures from plant resources.

Actions Performed:

Following the root cause analysis, the plant developed and implemented an action plan to address the issue, which resulted in several activities to achieve improvements in the effective implementation of protective actions. In the last two months the plant installed new dose rate meters with probes at the muster points in buildings 58 and 57 to assess the realistic possible radiation situation at the assembly point. However, the relevant documentation has not yet been revised, and the designated personnel for the use of these probes have not yet been trained or exercised.

In February this year, a new hand-foot monitor was installed to measure possible contamination of people in the muster point No.15 221. However, the relevant documentation has not been revised yet, which will be completed including the record keeping, how to maintain this equipment as well as the practical use during an emergency or exercise.

Also, as part of the improvement of the Emergency Response Organizations (ERO) key position recall system an option has been added to order these functions to come directly to the Back Up of Emergency Control Centre in Middelburg in the event of a deterioration of the situation at the plant. This is described in the N14-23-001 procedure with the last revision on 2025/05/01.

A physical inspection confirmed that the required quantities of iodine tablets with valid expiry dates are stored in the designated locations. However, the plant has not decided yet on the final distribution of iodine tablets, therefore the workplaces of first responders as main control room, fire station and the backup of the emergency response center in Middelburg town had not been provided with iodine tablets. Also, document N14 -23-200 of the facility manager (MOD) has not been fully completed on the issue of iodine tablets distribution.

The protection (equipment and procedures) of radiation technicians at the designated muster point No. 15 221 making measurements of potentially contaminated person had not been fully resolved in the procedure N17-30-001. Similarly, the protective equipment of security workplaces such as protective suits, overalls and gloves is still being addressed.

Results and Effectiveness:

During the plant tour, the team observed improvements achieved by the plant and activities in progress according to the plant's action plan. Relevant procedures have been updated to exclude the use of unauthorized operator aids. However, the overall work on organizational and procedural description of the strategy for the implementation of protective actions is still in progress. Revisions of some procedures, documents and organizational arrangements have not been completed. The plant is still developing a more systematic approach to store and distribute iodine tablets in a more effective manner and further updates were planned in the procedures for the protection of radiation technicians at the dedicated nuclear muster point.

The revised procedures, documents and newly installed modifications were to be tested in exercises (e.g. full exercise or partial exercises) and their evaluation was expected to show the efficiency of implementation of emergency arrangements for protection of personnel.

Conclusion: Satisfactory progress to date.

9.3. EMERGENCY PREPAREDNESS

9.3(1) Issue: The preparedness of the plant emergency facilities, equipment, and documentation is not comprehensive enough to ensure effectiveness of the emergency response organization.

During the review the team noted the following:

- In the Emergency Control Centre:
  - There were no permanently installed dose rate monitors inside the centre.
  - Oxygen and carbon dioxide measurements were not located within this centre.
  - According to the procedure N14-23-300 the radiation monitoring team had to verify the dose consequences for the people inside this centre. However, there was no explicit requirement in this procedure for directly measuring the air contamination inside this centre itself.
  - There was no inventory list in the room No15.109 for stored items such as food and sleeping bags.
  - Satellite phones were available for the main control room and the backup emergency control centre at site, but they could not be operated from the emergency control centre because there is insufficient signal strength.
  - There were no visual instructions for the decontamination process in the decontamination room No 15.105. Moreover, there was no installed disposal unit to hold a plastic bag for the disposal of contaminated clothing.
- In the Muster point No 15 221(designed for evacuated personnel from the control area):
  - There was no pre-prepared printed list available for the registration of the persons present, including the recording of the values from the personnel dosimeters.
  - The procedure N14-25-103 to be used by the radiation technician did not contain any instruction that portable radiation measuring devices are located in emergency control centre.
  - The procedure N17-30-001, which describes how the measurement of potentially contaminated persons had to be carried out, was not placed within the muster point.
  - The printed list of emergency response organization telephone contacts was not placed at this muster point.
  - At the outer entrance locked door on the wall there was an unmarked key. There was no instruction for the first arrivals to break the glass and use this key to open the door to the assembly area.
- Back Up of Emergency Control Centre in the Middelburg town:
  - 30 protective filters should be available in the cupboard of the technical support centre there. However, only 26 filters were present, and they all had an expiry date of 1 February 2023 which was the same date as they were observed.
  - No bottled water was stored in this centre, but bottled water was available at the primary ECC.

Without full readiness of the emergency facilities and equipment, the effective management and implementation of emergency arrangements and protective actions might be compromised in case of an emergency.

Suggestion: The plant should consider improving the preparedness of its emergency facilities, equipment and documentation to ensure effectiveness of the emergency response organization.

IAEA Bases:

SSR-2/2 (Rev.1)

5.7. Facilities, instruments, tools, equipment, documentation and communication systems to be used in an emergency shall be kept available and shall be maintained in good operational condition in such a manner that they are unlikely to be affected by, or made unavailable by, accident conditions.

GSR Part 7

6.22. Adequate tools, instruments, supplies, equipment, communication systems, facilities and documentation (such as documentation of procedures, checklists, manuals, telephone numbers and email addresses) shall be provided for performing the functions specified in Section 5. These items and facilities shall be selected or designed to be operational under the conditions (such as radiological conditions, working conditions and environmental conditions) that could be encountered in the emergency response, and to be compatible with other procedures and equipment for the response (e.g., compatible with the communication frequencies used by other response organizations), as appropriate. These support items shall be located or provided in a manner that allows their effective use under the emergency conditions postulated.

6.23. For facilities in categories I and II, as contingency measures, alternative supplies for taking on-site mitigatory actions, such as an alternative supply of water and an alternative electrical power supply, including any necessary equipment, shall be ensured. This equipment shall be located and maintained so that it can be functional and readily accessible when needed (see also Safety of Nuclear Power Plants: Design (SSR-2/1) [18])

6.34. The operating organization, as part of its management system (see Ref. [14]), and response organizations, as part of their emergency management system, shall establish a programme to ensure the availability and reliability of all supplies, equipment, communication systems and facilities, plans, procedures and other arrangements necessary to perform functions in a nuclear or radiological emergency as specified in Section 5 (see para. 6.22). The programme shall include arrangements for inventories, resupply, tests and calibrations, to ensure that these are continuously available and are functional for use in a nuclear or radiological emergency

5.27. For facilities in category I, II or III, arrangements shall be made, in particular by the operating organization, to provide technical assistance to the operating personnel. On-site teams for mitigating the consequences of an emergency (e.g., damage control, firefighting) shall be available and shall be prepared to perform actions at the facility. Paragraph 5.15 of Safety of Nuclear Power Plants: Design (SSR-2/1) [18] states that:
"Any equipment that is necessary for actions to be taken in manual response and recovery processes shall be placed at the most suitable location to ensure its availability at the time of need and to allow safe access to it under the environmental conditions anticipated."
The operating personnel directing mitigatory actions shall be provided with information and technical assistance to allow them to take actions effectively to mitigate the consequences of the emergency. Arrangements shall be made to obtain support promptly from the emergency services (e.g. law enforcement agencies, medical services and firefighting services) off the site.

Plant Response/Action:
The plant recognizes the issue.
The plant also recognizes the encouragement to better integrate the incident response, emergency response and crisis management.

Cause:
Emergency preparation is a cross functional process for which many departments/groups and individuals have responsibilities. Subsequent changes in the organization of emergency preparation (EP), with respect to the responsibility for EP, with respect to the resources dedicated to EP and in the integrated management system have led to the observed deficiencies.

Actions Performed:
Modification plans have been authorized to install a permanent dose rate meter and two CO2 meters in the ACC. The measurements have been installed.
The inventory lists have been updated, together with the list of the emergency response locations. The 6 monthly check is in place.
A satellite telephone is also available for data communication from the ACC.
Furthermore, in line with the encouragement of the OSART team, the plant launched a project to continuously improve the overall organization and procedural description of emergency preparedness and response. As an improvement measure from the 10-year periodic safety review 10EVA23, this project must be finalized at the latest in 2027. The project encompasses the establishment of the full scope of incident and emergency response, actualization of all procedures and organizational arrangements, description of the decision-making process during emergency response situations, securing the allocation of sufficient staffing and improvement of the provisions for emergency response.

Results and Effectiveness:
The dose rate meters and the two CO2 meters in the ACC have been installed.
Relevant procedures have been updated and the use of unauthorized operator aids has been strongly reduced.
The overall organizational and procedural description of EP is still under development. The dedicated project is one of the improvement measures of the periodic safety evaluation 10EVA23 which secures the completion of it.

IAEA comments:

Cause:
The plant carefully analysed the issue and identified the following root causes:
- deficiencies in the comprehensiveness of the procedures and the readiness of the plant emergency facilities and equipment related to the effectiveness of the emergency response organization,
- the lack of challenging of assumptions about emergency accident scenarios, related to insufficient consideration of the effective use of the designated facilities, equipment and procedures used in an emergency.

Insufficient emergency response organization staffing levels, competences assessments and documentation integration also contributed to this Issue.

Actions Performed:

Following the root cause analysis, the plant developed and implemented an action plan to address the issue, which resulted in several activities to achieve improvements in the preparedness of the plant emergency facilities, equipment, and documentation.

Actions related to the Emergency Control Centre (ECC) and its Back Up:
- During the previous week, new monitoring devices were installed to monitor the habitability of this ECC: one permanent dose rate meter and two carbon dioxide meters.
- From December 2024 an electronic personal dosimetry system with electronic dosimeters and reader is placed in room No 15.114 for members of emergency response organisation.
- Also, from May 12, 2025, satellite data transmission is available in the ECC.
- A new walkie-talkie system has been implemented in this ECC as well in the Back Up of the ECC on the plant.
- Inventory lists, including food and sleeping bags, have been updated and will be placed under QA controlled distribution in all relevant locations to avoid unauthorized documents.
- The process for decontamination of persons entering the ECC has not yet been sufficiently developed to be put into practice. The plant is currently analysing possible scenarios so that it can verify effective procedures using new measuring devices through practical exercises.
- In the procedure N14-26-029 there is a list of the materials which is available in the Back Up of the ECC in Middelburg, including number of filters. A physical inspection confirmed that the required quantities of filters with valid expiry dates are stored there. However, a responsible body and a frequence of the relevant inspections have not defined yet. The plant plans to proceduralize this process.

Actions related to the Muster point No 15.221:
- In December 2023, a personal dosimeter reader was installed at the muster point, the outputs of which are available within the radiation network to record the personal radiation doses of people who are evacuated from the control area in case of emergency.
- Some of the documentation relating to procedures for radiation technicians at this muster point has not yet been added to this location or has not been sufficiently revised, for example, to include in the records the new measurement for the contaminated persons that have been placed at this location for putting into practice its regular maintenance. The plant is working to improve the documentation, which is also linked to the resolution of the identified deficiencies.

The plant has established detailed procedures N14-26-xxx with inventory lists for the emergency response materials, means and equipment including surveillance programme. In connection with this process, the plant has established regular inspections of designated means, equipment and materials at a frequency of 2 x per year, including record keeping. The plant is still working to correctly identify owners for inspections of emergency material and equipment, so that maintenance of these means can be carried out in an efficient manner.

Results and Effectiveness:

New devices have been installed both in the ECC and at muster point No.15.221, which would significantly improve the monitoring of individuals as well as workplaces that are used by the Emergency Response Organization (ERO) members.

The plant is continuously working towards a more systematic approach to ensure the availability and reliable operation of required assets and equipment in the event of an emergency, which includes regular inspections of emergency facilities, equipment and materials, including maintenance and surveillance programmes.

Furthermore, the plant launched a project to improve the overall organization and procedural description of emergency preparedness and response. As an improvement measure from the 10-year periodic safety review 10EVA23, this project must be finalized at the latest in 2027. The project encompasses the establishment of the full scope of incident and emergency response, actualization of all procedures and of the organizational arrangements, description of the decision-making process during emergency response situations, securing the allocation of sufficient staffing, readiness of emergency facilities, equipment and other material and improvement of the provisions for emergency response.

Improvement measures and other actions taken by the plant in the last period since the OSART mission have ensured continuous improvement of the plant's emergency preparedness facilities, equipment and documentation to achieve an efficient emergency response organization.

Conclusion: Issue resolved.

10. ACCIDENT MANAGEMENT

10.2. OVERVIEW OF THE SEVERE ACCIDENT MANAGEMENT PROGRAMME

The nuclear power plant has a bunkered system with the necessary safety features. The system was designed to withstand extreme external events (such as floods and earthquakes). In addition, the nuclear power plant had two additional Severe Accident Management Guidelines (SAMG) procedures (EDMG-1 and EDMG-2) for events where there were no personnel on site to intervene (for example, in the event of an extreme external event or terrorist attack). The team recognized this as a good performance.

10.3. ANALYTICAL SUPPORT FOR SEVERE ACCIDENT MANAGEMENT

The plant's SAMG procedures contained some actions for the removal of decay heat from the reactor core e.g., external cooling of the reactor vessel by cold water, or pumping cold water into the steam generator by a low-pressure mobile pump. However, there was no computational analysis to determine what pressure the reactor vessel can withstand without damage of the reactor vessel when cold water is injected into the reactor cavity. Also, there was no analyses about the effectiveness of the cooling by pumping cold water into the hot reactor cavity or into the hot steam generator by a low-pressure mobile pump. The team encouraged the plant to enhance the basis for the ultimate heat removal strategies during severe accidents.

10.5. PLANT EMERGENCY ARRANGEMENTS WITH RESPECT TO SAM

A passive valve was installed at the plant to seal off the cooling line of the Reactor Coolant Pump (RCP) seals. This valve automatically and passively closes the RCP cooling line in the event of a plant power failure. This valve can delay RCP seal damage by approximately ten hours. The team recognized this as a good practice.

A new earthquake, storm and flood resistant building was built in 2017. The building is at a safe distance from the plant in the event of a plane crash. The building can ensure that the flexible and mobile equipment are not damaged in case of such events. The team recognized this as a good performance.

DETAILED ACCIDENT MANAGEMENT FINDINGS

10.5. PLANT EMERGENCY ARRANGEMENTS WITH RESPECT TO SAM

10.5(a) Good practice: The implementation of a passive Reactor Coolant Pump (RCP) seal isolation valve.

Purpose

The passive valve will isolate the RCP seals automatically in the early stages of a plant blackout event. Early isolation of the RCP seals will lead to a smaller temperature increase rate after failure of the seal cooling. Therefore, automatic isolation of the seals reduces the risk of RCP seal failure and subsequent primary coolant loss in situations when the Emergency Core Cooling System (ECCS) is not available.

Description

In an Extended Loss of AC Power event (ELAP), the strategy will be to isolate the RCP cooling manually and to cool down the primary system in order to reduce the risk of RCP seal failure. The plant implemented an ELAP procedure containing this strategy, including manual isolation of the seal cooling. The plant also implemented passive RCP isolation valves to reduce the risk of RCP seal failure even further. The rationale behind this is that the isolation should be carried out very early into an event but could be delayed due to possible electrical faults or task overload.

Benefits

- Passive isolation reduces the temperature increase rate of the seals. This delays the time to reach critical temperatures where the seals could fail by more than 10 hours. Failure of the RCP seals will lead to a loss of coolant accident.
- It reduces the potential requirement to exchange RCP seals.

14. USE OF PSA FOR PLANT OPERATIONAL SAFETY IMPROVEMENTS

14.1 ORGANIZATION AND FUNCTIONS

The plant established effective policies to foster an awareness of the personnel in the use of Probabilistic Safety Assessment (PSA). This awareness was not only limited to PSA staff, but also to plant departmental managers and team leaders and people involved in outage preparation and maintenance scheduling. The commitment to the use of PSA was exemplified in the fact that three key performance indicators (KPI) were based on a PSA metric (cumulative core damage frequency). In addition, Safety Monitor training was delivered to multiple plant departments as part of the Technical Specification training. The team recognized this as good performance.

14.4 USE OF PSA AND PSA APPLICATIONS

The plant established a detailed and intensive risk-informed process for scheduling maintenance activities during all Plant Operating Modes based on the use of the PSA Risk Monitoring application. The key performance indicators based on PSA, the recurrent risk profile analysis according to the INPO AP-928 methodology and the restricted risk-informed limits established, assures that action will be taken long before the risk gets significant. An example of this was the cumulative risk limit to take action during a single activity was set to 0.2% of the base risk. This means that, for this plant, the limit was almost two orders of magnitude more restrictive than the limit chosen by the other industry organization during the development of the Maintenance Rule. Therefore, the use of PSA for maintenance scheduling assures that the total risk from the plant remains low. In addition, the plant leadership reviews the results of the outage PSA risk profile and takes actions as required to minimize plant risks. The team recognized this as a good performance.

The plant performed independent verification when a Technical Specification change was going to be carried out. However, during a review of a temporary Technical Specification for the allowed outage time extension on the emergency diesel system (the EY100 system), the team identified that the independent verification was not completed in its entirety. PSA models and results for this specific risk-informed decision-making application were not reviewed. The team encouraged the plant to enhance the independent verification of safety assessments related to Technical Specification changes as established in plant procedures.

14.5 USE OF PSR AND OEF TO SUPPORT PSA APPLICATIONS

The plant developed a unique risk-informed application that categorizes the proposed areas of improvement identified in the Periodic Safety Review (PSR), according to deterministic and probabilistic risk benefits, in order to concentrate efforts in areas most beneficial to safety. Therefore, during each PSR, first the PSA model was updated to the 'state of the art', then with the new PSA results, a Weakness Report was issued where the potential improvements of the plant based on PSA metrics for both level 1 and level 3 were identified. Finally, the complete set of results from the PSR were ranked based on probabilistic and deterministic considerations. These ranking forms part of the plant decision on what measures to implement. The team recognized this process as good practice.

14.5. USE OF PSR AND OEF TO SUPPORT PSA APPLICATIONS

14.5(a) Good practice: The plant has developed a unique risk-informed application that categorizes the proposed areas of improvement identified in the Periodic Safety Review (PSR), according to deterministic and probabilistic risk benefits in order to concentrate efforts in areas most beneficial to safety.

Purpose

The goal of this application is to improve the review of PSR results in a risk-informed way that enhances plant safety.

Description

The use of the Probabilistic Safety Assessment (PSA) as part of the PSR follows the next structured multi-stage process:

- Definition of 'State of the Art' in PSA.
- Updating of the model to the 'State of the Art' standard.
- Use of the updated model to identify potential improvements of the plant based on the PSA metrics for both level 1 and level 3.
- In the next step, the complete set of results from the PSR are ranked based on probabilistic and deterministic considerations. These ranking forms part of the decision on what measures to implement at the plant.

POTENTIAL SAFETY IMPROVEMENT				
Core Damage Frequency	Individual Risk	Instantanous CDF		
Delta CDF (average /yr.)	Delta IR (average /yr.)	CDF above internal limit: CDF > 1E-4 /yr.		
Very big impact (>250%)	Very big impact (>250%)	Multiple times per year at EPZ	Very big	
Big impact (25-250%)	Big impact (25-250%)	1 or 2 times per year at EPZ	Big	
Significant impact (5-25%)	Significant impact (5-25%)	Did happen at EPZ (0,1 / year)	Moderate	
Limited impact (1-5%)	Limited impact (1-5%)	Did happen in the nuclear industry (1E-3 / year)	Small	
Negligible impact (0,2-1%)	Negligible impact (0,2-1%)	Never happened in the nuclear industry (1E-5 / year)	Very small	

Probabilistic thresholds for ranking of PSR measures

- The measures identified are incorporated in the PSA at an early stage as part of the license application following the PSR.

This approach was partially implemented during the PSR conducted in 1993 and was fully implemented during the PSR in 2003.

GA/SF -No.	Description of area	Safety Importance		PM-No.	Description of potential measure	Cost	Follow-up
		Det.	Prob.				
GA 01	**Extension of autarky and autonomous safety**						
SF 01.14	Capacity 24V- batteries GRID1 and GRID2			PM 01.07a	Increase capacity of 24V- batteries of Emergency GRID1 and Emergency GRID2 for monitoring of the plant. Consider 12 hours capacity based on EPR-benchmark.		None
				PM 01.07b	Provide mobile means to supply power to Emergency GRID 2 for monitoring and charging 24V-batteries.		CSA
SF 01.15	Capacity 220V- batteries GRID1			PM 01.08	Install UPS on bus bars CY/CZ for secondary bleed & feed and primary bleed.		10EVA
SF 01.16	PSRV's control from bunkered buildings			PM 01.09	• Control PSRV's from reserve control room or from cabinets • Provide power to the PSRV's from 380V batteries.		10EVA
GA 02	**Improvements on spent fuel pool cooling system (TG)**						
SF 01.05	Grading of TG-system			PM 02.01a	Adjust safety classification of the TG-system from class 3 to class 2.		None
				PM 02.01b	Apply surveillance and maintenance on the TG-system according to a class 2 system.		10EVA
SF 01.49	Independence of TG080 from TG020/030			PM 02.02	Connect the TG080-heat exchanger directly to the TG025-pump (separation of TG020/TG080).		10EVA
SF 01.51	Avoid potential failure of TG-pumps after containment isolation (YZ33)			PM 02.03	Additional flow measurements in the TG020 and TG030 trains to protect the TG-pumps.		10EVA

Combined deterministic and probabilistic evaluations of PSR measures

Benefits

The use of PSA to supplement the deterministic considerations ensures a complete and balanced approach of the PSR. The PSA specifically helps in identifying improvements for complex dependencies regarding nuclear safety at the plant. When using PSA for the ranking of improvements, it helps in the allocation of resources to areas most beneficial to safety.

By using the level 3 results of the PSA, the safety and protection of people and the environment local to the plant is taken into account alongside nuclear safety.

SUMMARY OF RECOMMENDATIONS, SUGGESTIONS AND GOOD PRACTICE

AREAS	RECOMMENDATIONS, SUGGESTIONS and GOOD PRACTICE
LMS	**Suggestion:** 1.1(1) The plant leadership should consider enhancing the ways in which it engages workers in initiatives to achieve excellence in operational performance.
TQ	**Suggestion:** 2.2(1) The plant should consider enhancing the monitoring and evaluation of training delivery to ensure that plant personnel attend the required training related to their duties.
OPS	**Recommendation:** 3.3(1) The plant should enhance the arrangements for the administration and control of operator aids to prevent the use of non-authorized operating documentation and other non-authorized material. **Suggestion:** 3.4(1) The plant should consider enhancing its arrangements for the management of leaks in order to ensure the correct identification, management and timely resolution of leaks. **Good Practice:** 3.2(a) The plant has implemented a ‘Man Down’ system to facilitate a quick response to individuals in an emergency. 3.2(b) The plant has introduced Bluetooth hearing protection to aid with communication in high noise areas.
MA	**Suggestion:** 4.2(1) The plant should consider enhancing its corrosion protection and inspection programmes to ensure timely identification, monitoring and correcting of safety and non-safety related SSC, whose failure could jeopardize the safe operation of the plant due to corrosion effects.
TS	**Suggestion:** 5.1(1) The plant should consider strengthening its programmes for System Health Monitoring and Obsolescence to ensure that they are robust and prioritized to ensure that the potential risk of degradation of the plant systems and components is minimized. **Good Practice:** 5.4(a) The plant has developed an easily applicable mechanism matrix to visualize ageing management activities in order to ensure effective ageing management of all SSCs in scope of its plant-level ageing management programme.
OEF	None
RP	**Recommendation:** 7.3(1) The plant should strengthen the radiation protection practices for contamination control, dose planning and the control of radioactive sources to ensure that the requirements of the radiation protection programme are fully met.

	Recommendation: 7.3(2) The plant should enhance the arrangements for resolving radiological field deficiencies in order to ensure that the deficiencies are addressed in a timely manner.
CH	**Suggestion:** 8.5(1) The plant should consider enhancing its worker implementation of chemical control practices to ensure appropriate identification, labelling, storage and safe handling with chemicals as well as accurate results of chemical analyses. **Good Practice:** 8.4(a) The plant uses the hydrazine concentration ratio as an additional indicator to evaluate the amount of sludge inside the steam generator.
EPR	**Suggestion:** 9.2(1) The plant should consider improving the plant provisions for protective actions in case of an emergency to ensure a timely and efficient emergency response. **Suggestion:** 9.3(1) The plant should consider improving the preparedness of its emergency facilities, equipment, and documentation to ensure effectiveness of the emergency response organization.
AM	**Good Practice:** 10.5(a) The implementation of a passive Reactor Coolant Pump (RCP) seals isolation valve.
PSA	**Good Practice:** 14.5(a) The plant has developed a unique risk-informed application that categorizes the proposed areas of improvement, identified in the Periodic Safety Review (PSR), according to deterministic and probabilistic risk benefits in order to concentrate efforts in areas most beneficial to safety.

SUMMARY OF STATUS OF RECOMMENDATIONS AND SUGGESTIONS OF THE OSART FOLLOW-UP MISSION

	RESOLVED	SATISFACTORY PROGRESS	INSUFFICIENT PROGRESS	TOTAL
Leadership and Management for Safety				
1.1(1) S	X			
Training and Qualification				
2.2(1) S	X			
Operations				
3.3(1) R	X			
3.4(1) S	X			
Maintenance				
4.2(1) S	X			
Technical Support				
5.1(1) S		X		
Operating Experience Feedback				
none				
Radiation Protection				
7.3(1) R		X		
7.3(2) R	X			
Chemistry				
8.5(1) S	X			
Emergency Preparedness and Response				
9,2(1) S		X		
9.3(1) S	X			
Accident Management				
none				
Use of PSA for Plant Operational Safety Improvements				
none				
TOTAL R	2	1	0	3
TOTAL S	6	2	0	8
TOTAL	8	3	0	11
	73%	27%	0%	100%

DEFINITIONS

Recommendation

A recommendation is advice on what improvements in operational safety should be made in the activity or programme that has been evaluated. It is based on inadequate conformance with the IAEA safety standards and addresses the general concern rather than the symptoms of the identified concern. Recommendations are specific, realistic and designed to result in tangible improvements.

Suggestion

A suggestion is advice on an opportunity for a safety improvement not directly related to inadequate conformance with the IAEA safety standards. It is primarily intended to make performance more effective, to indicate useful expansions to existing programmes and to point out possible superior alternatives to ongoing work.

Good practice

A good practice is an outstanding and proven programme, activity or equipment in use that contributes directly or indirectly to operational safety and sustained good performance. A good practice is markedly superior to that observed elsewhere, not just the fulfilment of current requirements or expectations. It should be superior enough and have broad enough application to be brought to the attention of other nuclear operating organizations and be worthy of their consideration in the general drive for excellence. A good practice is novel; has a proven benefit; is replicable (it can be used in other organizations); and does not contradict an issue. Normally, good practices are brought to the attention of the team on the initiative of the host organization. An item may not meet all the criteria of a ‘good practice’, but still be worthy to take note of. In this case it may be referred as a ‘good performance’ and documented in the text of the report.

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 nuclear installation. However, it might not be necessary to recommend its adoption by other nuclear installations, because of financial considerations, differences in design or other reasons.

Self-identified issue

A self-identified issue is documented by the OSART team in recognition of actions taken to address inadequate conformance with the IAEA safety standards identified in the self-assessment made by the host organization prior to the mission and reported to the OSART team by means of the Advance Information Package. Credit is given for the fact that actions have been taken, including root cause determination, which leads to a high level of confidence that the issue will be resolved within a reasonable time frame. These actions should include all the necessary provisions such as, for example, budget commitments, staffing, document preparation, increased or modified training, or equipment purchases, as necessary.

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 is still desirable, the given topic may be described in the text of the report using the phrase ‘encouragement’ (e.g., the team encouraged the host organization to…).

DEFINITIONS – OSART FOLLOW UP MISSION

Recommendation or Suggestion – Issue resolved

All necessary actions have been taken to deal with the root cause of a recommendation or suggestion rather than to just eliminate the facts identified by the team. A management review has been performed to ensure that actions taken have eliminated the root cause. Actions have also been taken to check that it does not recur. Alternatively, an issue is no longer valid due to, for example, changes in the operating organization.

Recommendation or Suggestion – Satisfactory progress to date

Actions have been taken, including root cause determination, which lead to a high level of confidence that a recommendation or suggestion will be resolved within a reasonable time frame, after the follow up mission. These actions might include, for example, budget commitments, staffing, document preparation, increased or modified training, equipment purchases. This category implies that a recommendation or suggestion could not reasonably have been resolved prior to the follow-up mission, either due to its complexity or the need for long term actions. This category also includes recommendations and/or suggestions 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.

Recommendation or Suggestion – Insufficient progress to date

Actions taken or planned do not lead to the conclusion that a recommendation or suggestion will be resolved within a reasonable time frame. This category includes recommendations and/or suggestions in response to which no action has been taken, barring recommendations and/or suggestions that have been withdrawn.

Self-identified issue – Issue resolved

All necessary actions have been taken, as defined in the self-assessment and the corresponding action plan, to address the root cause of an issue. A management review has been performed to ensure that actions taken have eliminated the issue. Actions have also been taken to check that it does not recur.

Self-identified issue – Satisfactory progress to date

Actions have been taken, as defined in the self-assessment made and the corresponding action plan to deal with the root cause and contributing causes, which lead to a high level of confidence that the issue will be resolved within a reasonable time frame.

Self-identified issue – Insufficient progress to date

The action plan developed to resolve the issue was not implemented as expected or did not achieve the expected results.

Recommendation or Suggestion – Withdrawn

The recommendation or suggestion is not appropriate due to, for example, a change in operating organization and/or structure, and/or the emergence of new, previously non-existent, circumstances associated with the identified issue.

REFERENCES

Safety Fundamentals (SF)

SF-1	Fundamental Safety Principles (Safety Fundamentals)

General Safety Requirements (GSR)

GSR Part 1	Governmental, Legal and Regulatory Framework for Safety
GSR Part 2	Leadership and Management for Safety
GSR Part 3	Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards
GSR Part 4 Rev.1	Safety Assessment for Facilities and Activities
GSR Part 5	Predisposal Management of Radioactive Waste
GSR Part 6	Decommissioning of Facilities
GSR Part 7	Preparedness and Response for a Nuclear or Radiological Emergency

Specific Safety Requirements (SSR)

SSR-2/1 Rev.1	Safety of Nuclear Power Plants: Design
SSR-2/2 Rev.1	Safety of Nuclear Power Plants: Commissioning and Operation

General Safety Guides (GSG)

GSG-2	Criteria for Use in Preparedness and Response for a Nuclear and Radiological Emergency
GSG-7	Occupational Radiation Protection
GSG-11	Arrangements for the Termination of a Nuclear Radiological Emergency

Safety Guides (SG)

NS-G-2.13	Evaluation of Seismic Safety for Existing Nuclear Installations
GS-G-2.1	Arrangement for Preparedness for a Nuclear or Radiological Emergency
GS-G-3.1	Application of the Management System for Facilities and Activities
GS-G-3.5	The Management System for Nuclear Installations
RS-G-1.8	Environmental and Source Monitoring for Purposes of Radiation Protection

Specific Safety Guides (SSG)

SSG-2 Rev.1	Deterministic Safety Analysis for Nuclear Power Plants
SSG-3	Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants
SSG-4	Development and Application of Level 2 Probabilistic Safety Assessment for Nuclear Power Plants

SSG-13 Chemistry Programme for Water Cooled Nuclear Power Plants

SSG-25 Periodic Safety Review for Nuclear Power Plants

SSG-28 Commissioning for Nuclear Power Plants

SSG-38 Construction for Nuclear Installations

SSG-39 Design of Instrumentation and Control Systems for Nuclear Power Plants

SSG-40 Predisposal Management of Radioactive Waste from Nuclear Power Plants and Research Reactors

SSG-47 Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities

SSG-48 Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants

SSG-50 Operating Experience Feedback for Nuclear Installations

SSG-54 Accident Management Programmes for Nuclear Power Plants

SSG-61 Format and Content of the Safety Analysis report for Nuclear Power Plants

SSG-70 Operational Limits and Conditions and Operating Procedures for Nuclear Plants

SSG-71 Modifications to Nuclear Power Plants

SSG-72 The Operating Organization for Nuclear Power Plants

SSG-73 Core Management and Fuel Handling for Nuclear Power Plants

SSG-74 Maintenance, Testing, Surveillance and Inspection in Nuclear Power Plants

SSG-75 Recruitment, Qualification and Training of Personnel for Nuclear Power Plants

SSG-76 Conduct of Operations at Nuclear Power Plants

SSG-77 Protection against Internal and External Hazards in the Operation of Nuclear Power Plants

International Labour Office publications on industrial safety

Guidelines on occupational safety and health management systems, International Labour office (ILO), Geneva, ILO-OSH 2001

Safety and health in construction, International Labour office (ILO), Geneva, ISBN 92-2-107104-9

Safety in the use of chemicals at work, International Labour office (ILO), Geneva, ISBN 92-2-108006-4

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IAEA

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IAEA Team Leader

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IAEA Deputy Team Leader

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REVIEWERS

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Company: NRA, Japan Nuclear Regulatory Authority
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Company: Leibstadt NPP
Review area: Radiation Protection

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Company: CEZ Group
Review area: Chemistry

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Company: Slovenske Elektrarne Mochovce NPP
Review area: Emergency Preparedness and Response

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Company: MVM Paks NPP Ltd.
Review area Accident Management

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Company: Iberdrola
Review area: PSA for Plant Operational Safety Improvement

OBSERVERS

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