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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

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

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.

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

FOREWORD
By the Director General

The IAEA Operational Safety Review Team (OSART) programme assists Member States to enhance safe operation of nuclear power plants. Although good design, manufacture and construction are prerequisites, safety also depends on the ability of operating personnel and their conscientiousness in discharging their responsibilities. Through the OSART programme, the IAEA facilitates the exchange of knowledge and experience between team members who are drawn from different Member States, and plant personnel. It is intended that such advice and assistance should be used to enhance nuclear safety in all countries that operate nuclear power plants.

An OSART mission, carried out only at the request of the relevant Member State, is directed towards a review of items essential to operational safety. The mission can be tailored to the particular needs of a plant. A full scope review would cover ten operational areas: Leadership and Management for Safety; Training and Qualification; Operations; Maintenance; Technical Support; Operating Experience Feedback; Radiation Protection; Chemistry; Emergency Preparedness and Response; and Accident Management. Depending on individual needs, the OSART review can be directed to a few areas of special interest or cover the full range of review topics.

Essential features of the work of the OSART team members and their plant counterparts are the comparison of a plant's operational practices with best international practices and the joint search for ways in which operational safety can be enhanced. The IAEA Safety Series documents, including the Safety Standards and the Basic Safety Standards for Radiation Protection, and the expertise of the OSART team members form the bases for the evaluation. The OSART methods involve not only the examination of documents and the interviewing of staff but also reviewing the quality of performance. It is recognized that different approaches are available to an operating organization for achieving its safety objectives. Proposals for further enhancement of operational safety may reflect good practices observed at other nuclear power plants.

An important aspect of the OSART review is the identification of areas that should be improved and the formulation of corresponding proposals. In developing its view, the OSART team discusses its findings with the operating organization and considers additional comments made by plant counterparts. Implementation of any recommendations or suggestions, after consideration by the operating organization and adaptation to particular conditions, is entirely discretionary.

An OSART mission is not a regulatory inspection to determine compliance with national safety requirements nor is it a substitute for an exhaustive assessment of a plant's overall safety status, a requirement normally placed on the respective power plant or utility by the regulatory body. Each review starts with the expectation that the plant meets the safety requirements of the country concerned. An OSART mission attempts neither to evaluate the overall safety of the plant nor to rank its safety performance against that of other plants reviewed. The review represents a 'snapshot in time'; at any time after the completion of the mission care must be exercised when considering the conclusions drawn since programmes at nuclear power plants are constantly evolving and being enhanced. To infer judgements that were not intended would be a misinterpretation of this report.

The report that follows presents the conclusions of the OSART review, including good practices and proposals for enhanced operational safety, for consideration by the Member State and its competent authorities.

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.

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 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.

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.

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.

3. OPERATIONS

3.2. OPERATIONS EQUIPMENT

The plant had introduced Bluetooth hearing protection to aid with communication in high noise areas. This initiative was introduced at the start of the COVID-19 pandemic in order to ensure clear and concise communications whilst maintaining social distance protocols. Due to the adaptability of the new Bluetooth hearing protection, it had been seamlessly integrated into the communication system in the plant and can also be used for conference calling, 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 a 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 a 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

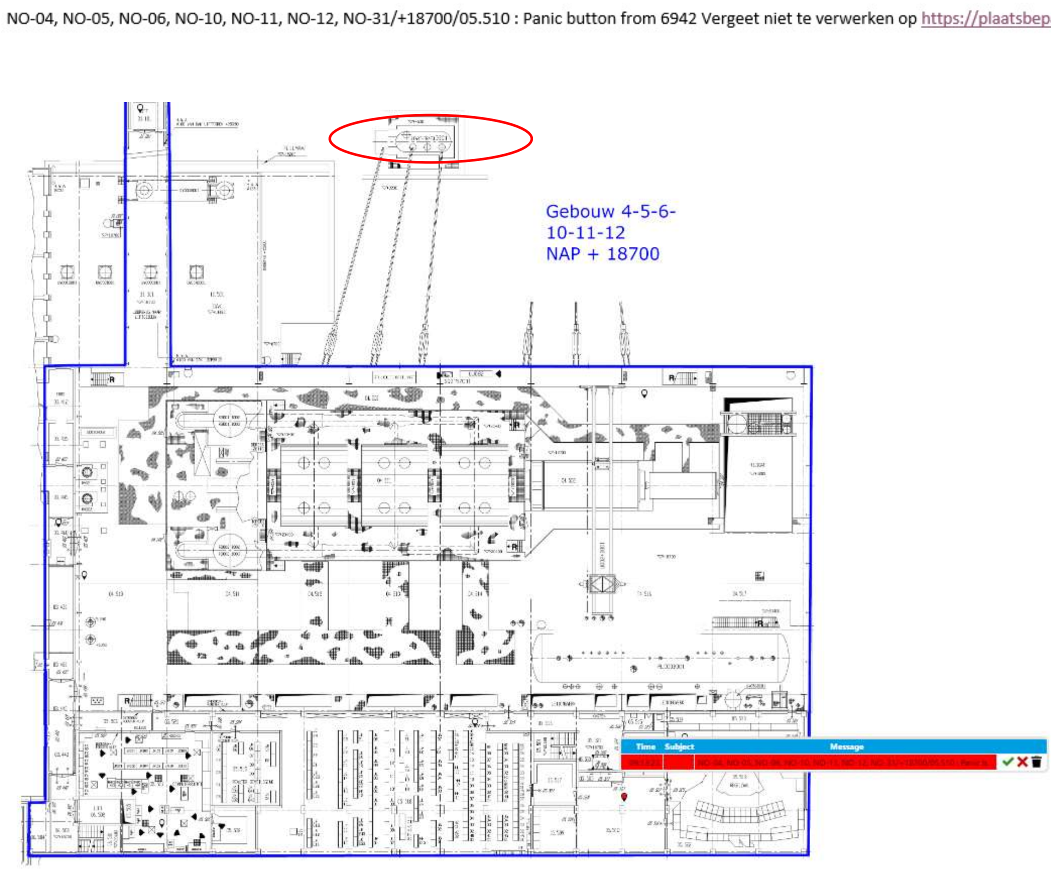
The purpose of the 'Man Down' system is to notify the Control Room when individuals out on plant are in distress or potential difficulty.

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 the 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 calling, 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 enables 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.

SSG-76

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

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.

SSG-76

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.

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 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 the 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 request 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.

SSG-74
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.

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 in 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 shall 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 was 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.

5.3 PROGRAMME FOR LONG-TERM OPERATION

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 were 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 furthered 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.

5.5(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 are intended 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 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 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. As a consequence, the number of on-site visits in the RCA is reduced, and hence optimizing 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 in a predefined distance. Indicating the distance with color LEDs, the tool enables the workers to measure in 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 fork lift 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.

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 a 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

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 of 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 a 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 unlabelled 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.

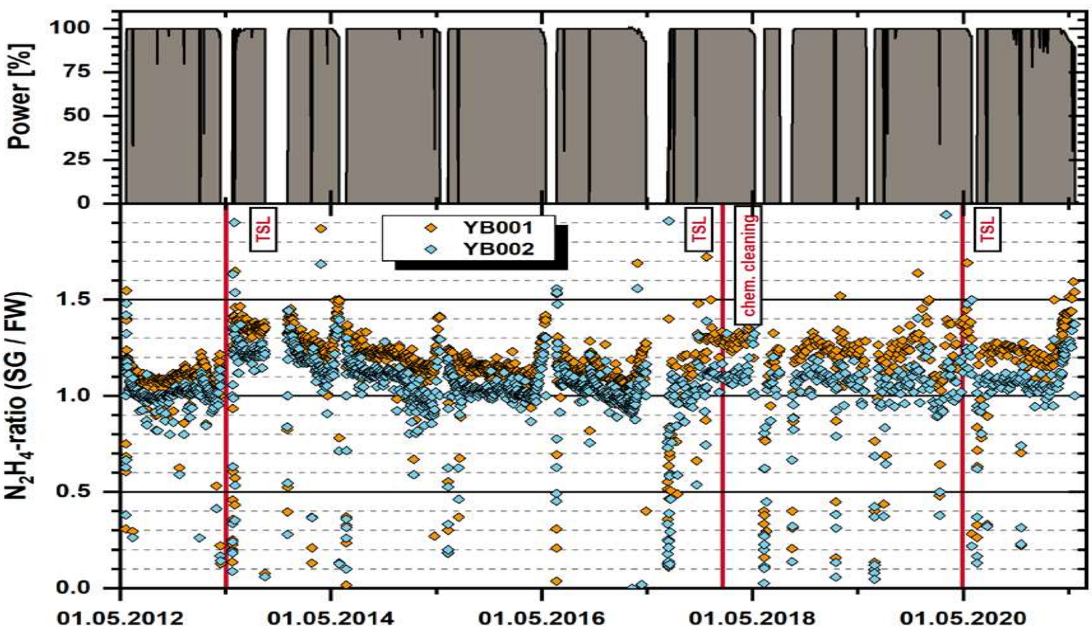
Description

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.

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.

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.

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 Black Out 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:** 5.5(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 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.

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…).

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

TEAM COMPOSITION

IAEA

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IAEA Team Leader

Morgan Simon - Years of nuclear experience: 23
IAEA Deputy Team Leader

Petofi Gabor - Years of nuclear experience: 23
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REVIEWERS

Simmons Paul Years of nuclear experience: 31
Company: NAWAH, United Arab Emirates
Review area: Leadership and Management for Safety

Morena Javier Pelaez - Years of nuclear experience: 31
Company: ANAV (Asociacion Nuclear Asco-Vandellos)
Review area: Training and Qualification

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Company: EDF Energy
Review area: Operations 1

Nguyen Stephanie Years of nuclear experience: 10
Company: EDF
Review area: Operations 2

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Company: CEZ Group
Review area: Maintenance

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Company: Vattenfall-Forsmark NPP
Review area: Technical Support

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Company: NRA, Japan Nuclear Regulatory Authority
Review area: Operating Experience

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Company: Leibstadt NPP
Review area: Radiation Protection

Rapouch Jiri Years of nuclear experience: 10
Company: CEZ Group
Review area: Chemistry

Mancikova Mariana Years of nuclear experience: 37
Company: Slovenske Elektrarne Mochovce NPP
Review area: Emergency Preparedness and Response

Vida Zoltan Years of nuclear experience: 34
Company: MVM Paks NPP Ltd.
Review area Accident Management

Osorio Francisco Years of nuclear experience: 27
Company: Iberdrola
Review area: PSA for Plant Operational Safety Improvement

OBSERVERS

Delalleau Jean-Charles Years of nuclear experience: 39
Company: Tihange NPP
Observer 1

Sanchez Berenice Mora Years of nuclear experience: 15
Company: CFE (Common Federal de Electricidad
Laguna Verde)
Observer 2