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REPORT

OF THE

OPERATIONAL SAFETY REVIEW TEAM

(OSART)

MISSION

TO THE

KRSKO

NUCLEAR POWER PLANT
SLOVENIA

15 MAY TO 1 JUNE 2017

DIVISION OF NUCLEAR INSTALLATION SAFETY
OPERATIONAL SAFETY REVIEW MISSION
IAEA-NSNI/OSART/194/2017

PREAMBLE

This report presents the results of the IAEA Operational Safety Review Team (OSART) review of Krsko Nuclear Power Plant, Slovenia. It includes recommendations for improvements affecting operational safety for consideration by the responsible Slovenian 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 Slovenian 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 nine operational areas: management, organization and administration; training and qualification; operations; maintenance; technical support; operating experience feedback; radiation protection; chemistry; and emergency planning and preparedness. 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 Krsko Nuclear Power Plant in Slovenia from 15 May to 1 June 2017.

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 thirteen areas: Leadership and management for safety; Training and qualification; Operations; Maintenance; Technical support; Operating experience feedback; Radiation protection; Chemistry; Emergency preparedness and response; Accident management; Human, technology and organization interaction; Long term operation 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 Armenia, Belgium, Bulgaria, Canada, the Czech Republic, Hungary, The Netherlands, Russian Federation, Spain, Sweden, Ukraine, United States of America and the IAEA staff members. The collective nuclear power experience of the team was approximately 350 years.

The team identified 20 issues, resulting in 4 recommendations, and 16 suggestions. 3 good practices were also identified.

Several areas of good performance were noted:

- The plant has implemented a tool allowing personnel to take a virtual panoramic tour using photos of technological areas. Multiple panoramic snapshots were taken inside the plant. The tool is available for all workers with access to a plant computer. Resulting in reduced radiation dose and improved the plant work planning;
- The plant, together with a vendor using state of the art 3-D printing technology, has reverse-engineered and produced an impeller to replace an obsolete item on a Fire Protection Pump;
- The plant has established a practice that assists in raising awareness of the plant staff on insights from the plant-specific Probabilistic Safety Assessment (PSA).

The most significant recommendations include:

- The plant should improve the programme for managers to reinforce their expectations of plant personnel behaviour and practices;
- The plant should enhance training programme for all personnel performing tasks important to safety, including emergency duties;
- The plant should improve the prioritization, implementation and monitoring of safety related activities to ensure their timely completion.

Krsko NPP management expressed their commitment to address the issues identified and invited a follow up visit in about eighteen months to review the progress.

CONTENT

INTRODUCTION AND MAIN CONCLUSIONS

INTRODUCTION

At the request of the government of Slovenia, an IAEA Operational Safety Review Team (OSART) of international experts visited Krsko Nuclear Power Plant from 15 May to 1 June 2017. 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, Emergency preparedness and response, Accident management, Human, technology and organization interactions, Long term operation 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 Krško Nuclear Power Plant is the only nuclear power plant in Slovenia. It is located on the north bank of the Sava River approximately 2 km southeast of the town of Krško in the east-southeast part of the Republic of Slovenia. The plant is equipped with a Westinghouse pressurized-water reactor with thermal power of 1994 MW and the net electrical output of the plant is 696 MWe. The Krško NPP was built jointly by the Republic of Slovenia and the Republic of Croatia. The supplier of the nuclear installation was the U.S. Westinghouse Electric Corporation. The plant became a nuclear facility in May 1981 when the initial core was loaded. First criticality was achieved in September 1981 and on 2 October 1981 the generator was synchronized for the first time to the grid. On 1 January 1983 commercial operation of the plant began.. The plant is connected to the 400 kV transmission system to cover the needs of consumers of Slovenia and Croatia.

The Krsko OSART mission was the 194th in the programme, which began in 1982. The team was composed of experts from Armenia, Belgium, Bulgaria, Canada, the Czech Republic, Hungary, The Netherlands, Russian Federation, Spain, Sweden, Ukraine, the United States of America and the IAEA staff members. The collective nuclear power experience of the team was approximately 350 years.

Before visiting the plant, the team studied information provided by the IAEA and the Krsko Nuclear Power 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 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 Krsko NPP are committed to improving the operational safety and reliability of their plant. Several areas of good performance were noted:

- The plant has implemented panoramic tour using photos of technological areas. Multiple panoramic snapshots were made inside plant technological areas. The tool is available for all workers with access to a plant computer, resulting in reducing radiation doses and improving the plant work planning;
- The plant together with a vendor using state of the art 3-D printing technology has reverse-engineered and produced an impeller to replace an obsolete item on a Fire Protection Pump;
- The plant has established a practices that assist in raising an awareness of the plant staff on insights from the plant-specific Probabilistic Safety Assessment (PSA).

The most significant recommendations include:

- The plant should improve the programme for managers to reinforce their expectations of plant personnel behaviour and practices;
- The plant should enhance training programme for all personnel performing tasks important to safety, including emergency duties;
- The plant should improve the prioritization, implementation and monitoring of safety related activities to ensure their timely completion.

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

1. LEADERSHIP AND MANAGEMENT FOR SAFETY

1.1. LEADERSHIP FOR SAFETY

For 2017, the plant added a 4th focus area after a self-evaluation in 2016: effective and efficient processes. This is mainly focused on outage preparation and procurement. The plant experiences delays in the procurement programme due to Public Procurement Law and long lasting appeal process leading to delays in starting some improvement plans. Examples include the Spent Fuel Dry Storage project and the construction of the Emergency facility. The team encouraged the plant to focus on the procurement process in close cooperation with different stakeholders involved in this programme.

The plant is gradually implementing a programme for managers to reinforce expectations in the field. The plant identified this as one of the 4 main focus areas for 2017 and is stressing the importance of this focus area to plant staff and managers. The team observed that the programme is not fully implemented. Not all managers are included in the programme and not all managers that are currently involved are complying with the programme. The team observed occasions where plant managers were not effectively reinforcing their expectations of personnel behaviour and practices, allowing gaps in industrial safety behaviours and gaps in adhering to deadlines. The team made a suggestion in this area.

1.2. INTEGRATED MANAGEMENT SYSTEM

The organizational structure and the management system are defined and documented in a comprehensive integrated management system. There are 5 defined core-processes, 4 management processes including nuclear oversight and 12 support processes. The management system integrates all elements including safety, health, environmental, security, quality, social and economic elements and assures that these are not considered separately from safety requirements. Integrated in this management system, the plant has a 5 year business plan MD-1 that is updated yearly and includes 5 year commitments and goals. These cascade down to department and section level goals. The yearly update of the performance agreements, including long-term investment needs, are signed between the owners and plant management. The team considered this a good performance.

Line management is responsible for defining necessary competencies and at the same time for staff development, knowledge management and knowledge retention. A plant procedure identifies the requirement for supervisors to conduct an annual conversation with workers to identify knowledge management vulnerabilities. However, there is no formal process to identify key-experts in the organization and knowledge transfer is not always started until an individual announces they are leaving. A programme on knowledge management is under development by the training department. The team encouraged the plant to further implement the knowledge management programme.

There is a clear ‘fitness for duty’ policy for plant staff that includes activities during initial hiring and a yearly re-examination. The exam includes medical health, psychological testing and testing for drug and alcohol abuse. The site security team has the authority to send workers acting abnormally to medical service to be checked, however no random checks (without cause) fitness-for-duty tests are performed. The team encouraged the plant to further strengthen the fitness-for-duty programme.

The plant has developed a comprehensive set of internal performance indicators to measure different aspects of the management system. The team noted that the plant does not always set goals that are challenging or that allow the plant to identify adverse trends in a timely way. The team observed discrepancies in the use of indicators to drive improvement by performing timely analysis, by defining corrective actions and leadership supervision. The team made a suggestion in this area.

1.3. DOCUMENT AND RECORDS MANAGEMENT

The plant keeps all valid documentation and all previous versions of documents in rooms equipped with fire protection systems, limited accessibility, and temperature and moisture control. The plant policy is to keep more documentation than legally is required for a longer period of time for all documents related to safety. Additionally the plant keeps maintenance records well beyond required end dates. Documentation important to safety is not only stored both on paper and electronically at the plant, but a duplicate is available in storage in the national capital. The team considered this as a good performance.

The process to create, update and control documentation is standardized. An appropriate document management system has been established and maintained and documents are reviewed and approved before they are issued. Procedures are to be used either step by step, as a reference, or for information and are marked accordingly. The specific rules are clearly defined in plant programmes and procedures. However, the team found procedures that were not always corrected and revised according to the plant QA rules. The team also noted examples of procedure quality flaws or incorrect use in different plant departments. The team made a suggestion in this area.

DETAILED LEADERSHIP AND MANAGEMENT FOR SAFETY FINDINGS

1.1. LEADERSHIP FOR SAFETY

1.1(1) Issue: Managers do not effectively reinforce their expectations of plant personnel behaviour and practices, allowing gaps in industrial safety behaviours and gaps in adhering to deadlines and processes.

The team noted the following:

- When supervising work or observing contractors and personnel or encountering other plant or contractor staff that do not adhere to plant industrial safety rules, neither managers, nor the plant staff present corrected them;
- Team supervisors and expert staff (for example maintenance component engineering, operations, system engineers and control room operators) are excluded from the observation programme;
- Training for leaders in task observation and coaching had been provided for 25 of 60 leaders. Redesign of the training is almost ready and training for the last group should be provided in the summer, however it is not scheduled yet;
- At the end of an observation performed by a manager, the feedback was a one-way communication of positive and negative observations, no questions were asked and no feedback was asked from the observed persons to check understanding and their engagement to improve performance. The feedback started while 4 workers were still cleaning the workspace after work and they missed the start of the feedback;
- The backlog of corrective actions has 1068 open items, some dating back to 1992;
- Not all managers comply with the plants expectation to perform 2 observations per month;
- The plant does not use a system of coach-the coach (paired observations);
- There is no procedure in place for observations of shift fire brigade rounds;
- Industrial safety hazards such as absence of safety signs regarding eye protection on accumulator battery rooms doors, level differences, unsafe access to valves were not identified and reported. Not all personnel and contractors consistently follow plant industrial safety rules. In 2015 and 2016 the plant had two events with injuries of personnel related to hitting unmarked hazardous parts of equipment which were in route paths;
- The plant manager considers that if he did not comply with the 2 observations per months, it would be non-consequential.

Without sufficient and systematic observations of actual work practices, effective coaching and reinforcement of expectations, the plant`s performance and industrial safety could be challenged.

Suggestion: The plant should consider improving the programme for managers to reinforce their expectations of plant personnel behaviour and practices.

IAEA Bases:

GS-G-3.1
2.16. The actions of managers and supervisors or team leaders have a strong influence on the safety culture within the organization. These actions should promote good working practices and eliminate poor practices. Managers and supervisors or team leaders should maintain a presence in the workplace by carrying out tours, walk-downs of the facility and periodic observations of tasks with particular safety significance.

3.6. Managers should examine samples of work practices and related information on a regular basis to identify areas needing improvement.

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.

6.53. Senior management should ensure that those performing work are aware of and use the process for prompt notification and reporting of non-conformances.

6.71. Senior management should ensure that corrective actions are subject to approval, prioritized and completed in a timely manner, on the basis of their significance. Managers should be held accountable for meeting due dates for corrective actions. Extensions or exceptions to due dates for completing corrective actions should be controlled and should be made only in response to new issues of higher priority.

INSAG-15

3.1. COMMITMENT
… Questions which might test the real commitment of an organization to safety include the following:
… (b) Are senior staff seen to be fulfilling these expectations themselves? For example, is safety the first item on the agenda at their meetings? Do they attend sites wearing appropriate personal protective equipment? Are managers seen to be devoting time and resources to safety, for example, spending a substantial proportion of their time at the plant looking specifically at the level of safety actually being achieved, and to challenging and praising different practices?

1.2. INTEGRATED MANAGEMENT SYSTEM

1.2(1) Issue: The plants internal performance indicators are not fully utilized as a management tool to detect, analyze and correct shortfalls in performance.

The team noted the following examples of the plant not always setting challenging goals or missing opportunities to detect adverse trends in a timely manner:

- From the 18 station management indicators:
  - Indicator 21116 ‘Annual goal of unplanned automatic scrams’ is <= 2 per 3 years (=0,67 or lower). When comparing this goal to industry achievements, it does not reflect the site’s aim to be one of the best performing plants;

  - Not all indicators have goals that challenge current performance: Indicator 13100 ‘Number of significant events’: result 2016 is 1, goal 2017 is <= 5 and will decrease to 4 in 2020. Indicator 11400 ‘Performance indicator index’ goal 2017 is >= 93 and will be increased to 95 in 2020, while the result was 91,26 in Q1 2015, above 99 since Q2 2015 and reached 99,89 in Q1 2017;
  - Indicator 31330 ‘gaseous effluent activity’ part ‘Total Dose’ indicator results are 0,61% and lower than 1,6% for more than a year (the period the indicator dates back). The strategic goal is set at <= 20%.
- The plant indicator 12210 ‘Chemistry performance indicator’ strategic goals are set at a value below the industry lower quartile values;
- RP related performance indicators, which are tracked at the plant level, lack challenging targets. In some cases the values of the indicators have been zero for the reviewed period but the targets remain much higher;
- In some cases the PIs are based on low expectations and useless for performance analysis. For example: PI «Duration of Annual Outage’. The goal is 28 days and last two outages lasted 36 days each; but the indicator counts outage days one 3 years. As there was no outage in the 2015 calendar year, the three year value is green – (0+36+36) / 3 = 24. When asked, personnel explained that this performance indicator was introduced before 2005 prior to the transfer from 12 to 18 month fuel cycles, and has not been revised since then.

Additionally, not all recent data is available:

- The plant indicator 31435 ‘number of near miss industrial safety’ events was last updated on 06/12/2016 and the plant indicator 31445 ‘severity of injuries at work’ was last updated on 12/01/2017.

The team observed discrepancies in the use of indicators to drive improvement by performing timely analysis, by defining corrective actions and leadership supervision.

- During a KOC (operating review committee) meeting only the first 6 of the 18 site indicators and only the 3 red indicators out of the 163 site indicators were discussed. Neither the indicator analysis and actions form, nor the discussion, resulted in adverse an approved action plan;
- The plant did not discuss all yellow indicators nor white indicators showing a negative trend at the KOC meeting. This does not conform to plant procedure ADP-1.0.022;
- Examples of the indicator owners not complying with plant KPI monitoring procedure ADP-1.0.022 rev 1 where it is stated that analysis and corrective actions should be made whenever there is a red indicator, a yellow indicator or a negative trend are:
  - Indicator 12162 ‘adherence to schedule finish’ is red for the monthly value and yellow for the 12 month rolling average value since 07/2016 and is showing a decreasing trend. There is a brief comment in the analysis part mentioned on the KOC meeting from January 22 2013 stating that the thresholds were changed, no cause for discrepancies, analysis on corrective actions are proposed nor communicated on the indicator.
  - Indicator 11200 ‘Unplanned capability loss factor’ is yellow and there is a brief comment on cause for discrepancies, however analysis and corrective actions are not proposed nor communicated on the indicator.
  - Indicator 21117 ‘number of unplanned shutdown’ shows an adverse trend and is scored white. However, the analysis and corrective action part of the indicator contains

only the list of last events that contributed to the degradation and no action nor analysis.
  - Indicator 11300 ‘Forced Loss Rate’ is 0 since before 2014, however since February 2017 the indicator shows an adverse trend and has evolved to 0.9% (12 month rolling average) in 3 months. 0.9% is close to the threshold for a yellow score (1%). However, the analysis and corrective action part of the indicator contains only the list of last events that contributed to the degradation and no action nor analysis.
  - Indicator 12163 ‘number of work orders planned 4 weeks in advance’ is yellow since November 2016. The latest comment in the analysis section dates back from October 15 2015, stating that poor work preparation was the cause, no corrective actions are proposed nor communicated on the indicator.
  - Indicator 12180 is white and shows a negative trend. It was red and yellow in November 2016 and December 2016 respectively. The latest comment in the analysis section dates back to February 2014, stating that the thresholds were changed, no cause for discrepancies, analysis and corrective actions are proposed nor communicated on the indicator.
  - Indicator 31510 ‘percentage of overdue corrective actions’: the strategic goal is set at 10%. The indicator has been white (between 10% and 30%) since the period the indicator dates back (one year). The latest comment in the analysis section dates back to January 2009, no cause for discrepancies, analysis and corrective actions are proposed nor communicated on the indicator.
- There are around 160 PIs for the Plant; from which 24 are related to operations, and only 5 of them are direct Operations responsibility. None of those is used at OPS management level on a daily or weekly basis to access performance.
- Self-assessment of the radiation protection department is performed every year and is presented to the technical operations director. It lacks detailed evaluation of performance indicators, which are required by a related procedure. There are no targets set for the indicators nor are trends evaluated.
- No condition requests were raised for Red and Yellow performance indicators, many of which have been red or yellow for greater than 6 months.

Without setting clear and challenging goals, the plant could miss the opportunity for objective self-evaluation. Without a periodic review of performance, the plant may miss opportunities to detect adverse trends at early stages and implement appropriate corrective actions.

Suggestion: The plant should consider reinforcing its practices in setting and updating goals and using these as per expectations as a management tool to analyze and improve performance.

IAEA Bases:

SSR-2/2 Rev. 1

Requirement 9:

4.34: … Where practicable, suitable objective performance indicators shall be developed and used to enable senior managers to detect and to react to shortcomings and deterioration in the management of safety.

GS-G-3.1
2.36. A strong safety culture has the following important attributes:
...Safety performance indicators are tracked, trended, evaluated and acted upon.

5.32. Performance indicators should be developed for each process to measure whether or not performance is satisfactory. Performance indicators should have particular emphasis on safety and should be monitored so that changes can be recorded and trends can be determined.

5.33. Trends in performance indicators should be analysed to identify both beneficial and adverse factors. … The causes of adverse factors should be determined and eliminated.

6.6. The purpose of self-assessment by senior management should be to identify, correct and prevent management problems that hinder the achievement of the organization's objectives. … Self-assessment by senior management should evaluate issues such as: —Are the plans and goals of the organization still appropriate and valid?

6.19. Various methods of self-assessment may be used. Examples of self-assessment techniques include the following: ... -Benchmarking to identify opportunities for improvements in performance;

6.47. Inputs that will allow the evaluation of the efficiency and effectiveness of the management system in the review should cover: ... -Results from benchmarking activities;

GS-G-3.5
6.3. Managers normally perform oversight reviews and assess the performance of activities through their day-to-day line management activities. Other, more structured mechanisms include: … (b) Reviewing the achievement of goals, strategies, plans and objectives: ...-Measurement of performance against set plans and targets using established performance indicators;

1.4. DOCUMENT AND RECORDS MANAGEMENT

1.4(1) Issue: Shortfalls in the use of written procedures, procedure adherence and adherence to review, revision and validation process do not ensure adequate response during emergency conditions, operation and testing of plant equipment important to plant safety.

Examples include the following:

- Some procedures for maintaining emergency response equipment on standby are coded the same as those for response during a plant emergency;
- Turbine hall 100: Operator aids, describing use of fire protection system valves, are located in the field close to related equipment. These aids refer to procedure ADP-1.3.028 but with different information to the latest revision of that procedure;
- A checklist used for completion of a diesel generator surveillance was not properly completed. A step was omitted during the testing;
- The vibration monitoring points are not marked on the pump, they were specified in the procedure for vibration testing of the auxiliary feed water pump but the procedure was not at the worksite during the test;
- A chemistry technician did not notify the main control room as required by procedure when obtaining a reactor coolant sample. The SOP (standard operating procedure) directs the technician to notify the Main Control Room before a sample valve is opened and later when the valve is closed;
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- Validation process for operational and surveillance procedures described in ADP-1.3.022 is not systematically utilised for Operating Surveillance Procedures;
- Validation Form appendix 6.2 of Procedure ADP-1.3.022 includes two pages, but an example of performed validation for SOP3.2.510 R3 dated 28.2.2017, has only one page with signatures without names of individuals involved and the second page was not used;
- The procedure EIP-17.504 ‘criteria for enrolment in ERO (Emergency Response Organisation) and notification book updating’ has not been updated and contains hand-written corrections for minimum staff in the ERO;
- Procedure OSP-3.4.591 has not been timely revised as expected by the plant: last approval date 16.03.2012.
- Management Programme MD-10 establishes requirements for periodic review of plant programmes ‘…at least every five years…’, but the programme itself - Management Programme MD-10 did not meet this expectations. The review cycle for this programme appeared to be 6 years and 4 months.

Without valid and timely review and revisions to written procedures and rigorous procedure adherence for tasks important to plant safety, the potential exist for improper operation of plant equipment.

Suggestion: The plant should consider reinforcing guidance for use of written procedures, procedure adherence and adherence to review, revision and validation process.

IAEA Bases:

SSR-2/2 Rev. 1

Requirement 8:

The operating organization shall ensure that safety related activities are adequately analysed and controlled to ensure that the risks associated with harmful effects of ionizing radiation are kept as low as reasonably achievable.

4.26 All activities important to safety shall be carried out in accordance with written procedures to ensure that the plant is operated within the established operational limits and conditions.

6.9. Operating procedures and test procedures shall be verified to ensure their technical accuracy and shall be validated to ensure their usability with the installed equipment and control systems. Verification and validation of procedures shall be performed to confirm their applicability and quality, and to the extent possible shall be performed prior to fuel handling operations on the site. This process shall continue during the commissioning phase. Verification and validation shall also be carried out for procedures for overall operation.

7.4. Operating procedures and supporting documentation shall be issued under controlled conditions, and shall be subject to approval and periodically reviewed and revised as necessary to ensure their adequacy and effectiveness. Procedures shall be updated in a timely manner in the light of operating experience and the actual plant configuration.

8.3 The operating organization shall develop procedures for all maintenance, testing, surveillance and inspection tasks. These procedures shall be prepared, reviewed, modified when required, validated, approved and distributed in accordance with procedures established under the management system.

NS-G-2.2
8.1. All safety related activities shall be performed in conformity with documents issued in accordance with approved administrative procedures. The availability and correct use of written OPs, including surveillance procedures, is an important contribution to the safe operation of a nuclear power plant.

NS-G-2.4
6.10. The operating organization should establish a document control system to ensure that all documents affecting activities important to safety are issued, updated, filed and distributed in such a manner as to prevent the use of superseded documents.

6.75. Documentation should be controlled in a consistent, compatible manner throughout the plant and the operating organization. This includes the preparation, change, review, approval, release and distribution of documentation. Lists and procedures for these functions should be prepared and controlled.

6.76. Particular care should be taken in order that, although all versions of each document are appropriately filed and kept as a reference, only the correct, up to date versions are available to the site personnel for day to day activity.

2. TRAINING AND QUALIFICATIONS

2.2 CONDUCT OF TRAINING AND QUALIFICATION

Plant workers receive initial training which enables them to perform well when first hired. For operations department the systematic approach to training is applied consistently and line ownership for the incumbents is evident. In contrast, periodic confirmation of qualification of plant workers from other technical departments, including qualification for emergency duties, does not receive a rigorous review and oversight from training management to hold line managers accountable. The team made a recommendation in this area.

Training for industrial safety is not based on performance of workers in the field. During field observations insufficient practices for the use personal protective equipment, lifting equipment and use of proper tools were observed. These include no hard hat, proper ear protection and use of lifting and rigging slings and exclusion area for walking below live loads and unsafe use of cutting tools in the controlled area. The deficiencies were observed by reviewers, but not emphasised in training for industrial safety. The team encourages the plant to address performance in the field in the training programmes.

The team observed that the plant simulator can be used to train relevant staff in the event of a plant emergency and specifically training for beyond design basis accidents. This simulator capability is regularly used during emergency preparedness drills including hands-on-training for mobile equipment. For example, during a 36 hour drill, operator response time is validated to predict human performance in an emergency for use in the Probabilistic Safety Analyses. The team recognized this as a good performance.

DETAILED TRAINING AND QUALIFICATION FINDINGS

2.2. QUALIFICATION AND TRAINING OF PERSONNEL

2.2(1) Issue: The plant arrangements for training and qualification do not always ensure adequate oversight, identification of training needs and periodic confirmation of qualification of plant personnel who perform activities important to safety, including emergency duties.

The team noted the following:

- There is a back log of about 25% of training and qualification activities. The back log is caused by database structure problems, poor involvement of the line managers and recording;
- 27 permanent contractors work at the mechanical maintenance department. Although the same training is provided to NEK staff, the training matrix database is not used for the permanent contractors;
- For maintenance work on emergency diesel generators, batteries and calibration there are no requirements for requalification in the training matrix database;
- The Radio-Chemistry Technician stated he has not received training on taking diluted samples;
- The Training Programme for Emergency Response includes an evaluation method (exam) only for the initial Emergency Response Organization general training;
- On-the-job performance metrics for drills in the Emergency Training Programme are not consistently based on Systematic Approach to Training methodology;
- For infrequently carried out tasks in RP periodic confirmation of on the job training is not required in the training matrix database;
- Requalification records of chemistry staff are not maintained by the training department. Training department has no information about the requalification process of the chemistry department;
- Required qualifications of Engineering and Maintenance department personnel is performed based on management experience and it is not based on any analyses;
- No analysis is done to determine if requalification or refresher training is required for required Root Cause Analysis and trending training;
- Some required training in the engineering department is now no longer required but has not been deleted from the training matrix;
- Performance indicators for training cover only operations and maintenance departments;
- Plant procedures are used as references for yearly self-assessment of the training activities. International standards like IAEA safety guides and WANO guidelines are not used as a reference for self-assessment on training;
- Procedure TSD-13.103, selection of the required training is not based on any risk analyses or formal job analyses.

Shortfalls in oversight, identification of training needs and periodic confirmation of qualification of plant personnel may have an adverse effect on performance of tasks important to safety, including emergency duties.

Recommendation: The plant should ensure that adequate oversight, identification of training needs, and periodic confirmation of qualification cover all personnel performing tasks important to safety, including emergency duties.

IAEA Bases:

SSR-2/2 Rev.1

Requirement 7:

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

4.16. The operating organization shall clearly define the requirements for qualification and competence to ensure that personnel performing safety related functions are capable of safely performing their duties. Certain operating positions may require formal authorization or a license.

4.18. The management of the operating organization shall be responsible for the qualification and the competence of plant staff. Managers shall participate in determining the needs for training and in ensuring that operating experience is taken into account in the training. Managers and supervisors shall ensure that production needs do not unduly interfere with the conduct of the training programme.

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. The refresher training shall also include retraining provision for personnel who have had extended absences from their authorized duties. The training shall emphasize the importance of safety in all aspects of plant operation and shall promote safety culture.

Requirement 18:
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.

GSR Part 7
Requirement 25:
The government shall ensure that personnel relevant for emergency response shall take part in regular training, drills and exercises to ensure that they are able to perform their assigned response functions effectively in a nuclear or radiological emergency.

NS-G-2.8

3.1. Qualification is a formal statement resulting from an assessment or audit of an Individual’s competence to fill a position and perform all duties assigned to that position in a responsible manner. Competence is the ability to apply skills, knowledge and attitudes in order to perform an activity or a job to specified standards in an effective and efficient manner. Competence may be developed through education, experience and formal training. For specific safety related functions, several competence criteria may need to be satisfied, and competence should be acquired by a combination of the above mentioned methods. When competence is being assessed the qualification becomes a formal statement of competence.

3.2. The operating organization should ensure that all personnel who may be required to perform duties that affect safety have a sufficient understanding of the plant and its safety features and sufficient other competences, such as management and supervisory skills, to perform their duties safely. In a graded approach according to their assigned duties and tasks, all personnel should be trained in safety management in their areas of responsibility.

3.3. Before undertaking any safety related work, staff should demonstrate the appropriate knowledge, skills and attitudes to ensure safety under a variety of conditions relating to their duties. Staff should be trained in the safety management principles that are of relevance to their work, and in how to promote safety culture and conservative decision making by means of positive feedback and recognition.

3.7. The competence of each individual should be assessed against established requirements before that individual is assigned to a position. The competence of all individuals should be fully assessed periodically by various means while they perform the duties allocated to their position; the assessment should also cover the actual individual performance in the workplace. The requirements should be established in such a way as to ensure that the competences are appropriate to the tasks and activities to be performed.

3.8. Appropriate records of assessments against competence and qualification requirements should be established and maintained for each individual at the plant.

3.10. Irrespective of any formal authorization issued by other bodies, it should be the responsibility of the operating organization to ensure the appropriate qualification of all on-site and off-site personnel. The responsibility of ensuring that individuals remain appropriately qualified should rest with the operating organization, although individuals should accept some responsibility in maintaining and developing their own competence through continuing professional training.

3.11. It should be the responsibility of the operating organization to ensure that qualification requirements are established for positions in the organization. The need for specific skills and knowledge will be different for different functional levels and positions. The balance between managerial and technical competences should be evaluated by the operating organization in establishing qualification requirements.

3.40. Contractors may perform a considerable part of the activities relating to safe operation of the plant, even though the prime responsibility for safe operation rests with the operating organization. The operating organization should ensure that contractor personnel involved in safety related activities are competent, qualified and medically fit to perform their assigned tasks.

5.24. Controls should be established to ensure that maintenance personnel are qualified to operate the equipment on which they are assigned to work. This qualification could be based on training given by the component manufacturer, training on equipment mock-ups or on the job training under the supervision of experienced staff. Maintenance personnel should have access to mock-ups and models for training in those maintenance activities that have to be carried out quickly and cannot be practiced with actual equipment.

3. OPERATIONS

3.1. ORGANIZATION AND FUNCTIONS

The team observed that some operations practices are not well prioritized, implemented and monitored to ensure safe operation of the plant. This is related to prioritization and control of timely implementation of safety related corrective actions, such as revision of procedures; requirements for equipment testing. Despite the fact that the plant has corrected some of the identified deficiencies during the time of the review, the team has made a recommendation in this area.

3.2. OPERATIONS FACILITIES AND OPERATOR AIDS

The plant has introduced an integrated computer system covering basic scope of the various operations processes in the plant Operations. Automation of operations processes is the key change in the operations department and present good platform for further improvements in development of operation standards and effective use of operations resources. While the practice of such automation for selected operations processes is known in the nuclear industry, the distinguishing approach of the plant is the integration of all basic operation processes in one software application available at PC terminals throughout the plant, that assist in the management of plant operations. The team recognized this as a good performance.

3.4. CONDUCT OF OPERATIONS

The plant has introduced an MCR projection screen which is scrolled down from the ceiling when needed to conduct shift team meetings (obligatory) or pre job briefings (if necessary). The purpose of the projection screen is to visualize information necessary for day to day operation and thus provide better preparation for the job of all involved. The team recognized this as a good performance.

The plant has implemented panoramic tour using photos of technological areas. Multiple panoramic snapshots were made inside plant technological areas in different elevations of buildings. The tool is available for all workers with access to a plant computer. Benefits provided by this software result in reduced radiation dose and improved the efficient use of plant working time. The team has identified this as a good practice.

3.6 FIRE PREVENTION AND PROTECTION PROGRAMME

The plant has established a consistent fire prevention and protection programme. However, some plant arrangements for evaluation, authorization and control of combustible materials and development of fire response strategies do not ensure robust fire prevention and protection. Plant procedures do not provide requirements on evaluation and approval of combustible materials in non-technological areas. The plant process for control of fire loads has gaps. The plant fire fighting strategies do not address all necessary attributes and do not encompass all fire areas important to safety. The team has made a recommendation in this area.

The plant has organized rotation of fire fighters between the plant shift fire brigade and the local professional fire brigade. This provides the ability for professional firefighters from the community to gain experience in real interventions and also gain knowledge of the plant. The team has identified this as a good performance.

DETAILED OPERATIONS FINDINGS

3.1. ORGANIZATION AND FUNCTIONS

3.1(1) Issue: Some operational practices are not prioritized, implemented and monitored to ensure safe operation of the plant.

The team noted the following:

- During the daily screening meeting and daily management meeting no communication was observed regarding prioritization of safety related activities. The backlog of open actions was not checked for overdue dates of safety related activities. Operations had 8 corrective actions, requesting review of overdue operating procedures for safety related equipment;
- Following a safety analysis, revision of procedure SOP-3.2.102 'CVCS Charging and Let-down' (The Chemical and Volume Control System) was requested on 11.11.2015 with the due date 30.06.2016. Later the revision due date was rescheduled to 30.09.2016 and then to 20.04.2017. At the time of the review the revision of the procedure was not done even though the revision includes an action related to a precaution in the text affecting reactivity control;
- Following a modification which included replacement of an Auxiliary Feedwater Pump (in outage of October 2016), Operations were to conduct 'Post-modification revision of a procedure SOP-3.2.110 'Auxiliary Feedwater System.' The revised version of the procedure showed some deficiencies. The work request for correction was issued on 27.11.2016, with due date 28.04.2017. Two other corrective actions regarding the same procedure were also overdue;
- Following replacement of internals of the control valve (Seal injection for reactor cooling pump), Operations were to revise a procedure GOP 3.1.500 'Hot standby to hot shutdown and cold shutdown'. Action was issued on 18.06.2015; The Safety Analysis was approved on 22.10.2015. The revision was not completed as part of the modification. It has been postponed from 31.12.2016 to 07.04.17 but was still outstanding at the time of the mission;
- Operations were put in charge of development of a new Appendix to EOP procedure governing 'how to fill the Refuelling Water Storage Tank with the use of mobile equipment'. The action was issued on 16.04.2016. Due date was 21.04.2017. It has been postponed 3 times previously;
- The existing software application for administering corrective actions, has no clear direct way to select safety related activities from the total backlog;
- The requirements for testing of severe accident management equipment (SAME) are not are not optimal and do not correspond to the level of its safety significance:
  - Equipment is considered as extended design normal operation equipment;
  - Procedure for the test of alternate diesel generator (DG) OSP-3.4.391 includes only technical sequence of actions for the test. Industrial and fire protection precautions, responsibilities of participating departments (testing, electrical maintenance, operations) are not included or clearly described in the procedure;
  - For this test the expectation is to use «informal» pre-job briefing;
  - Check list for DG AE900DSL-002 test pre-job briefing in MCR was not used, safety measures were not addressed;
  - At the post-job brief the check-list of parameters, filled-in by the operator during the test, missed one step and had not been signed;
- MCR measuring devices calibration practice for safety related equipment is not consistent:

- Missing calibration marks on panel 17 for current measurer II2745 (Component Cooling pump), Spent fuel pit pump control FI 1419A, and on panel 14 SI (Safety Injection) pump 1 and pump 2.
- All measuring devices on a panel SYEB01 110 kV Polje LP NEK have no calibration data.
- Measuring devices on nearby panel SYCA02, SYCA01 have calibration marks with dates back to 2011.

Improper prioritization, implementation and monitoring of operations activities, could adversely affect safe operation of the plant.

Recommendation: The plant should improve the prioritization, implementation and monitoring of operations activities to ensure activities related to safety are completed in a timely manner.

IAEA Bases:

SSR-2/2 Rev.1
Requirement 1: Responsibilities of the operating organisation.
The operating organization shall have the prime responsibility for safety in the operation of a nuclear power plant.

3.2.The management system, as an integrated set of interrelated or interacting components for establishing policies and objectives and enabling the objectives to be achieved in an efficient and effective manner, shall include the following activities: …(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.

NS-G-2.14

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.

3.4. CONDUCT OF OPERATIONS

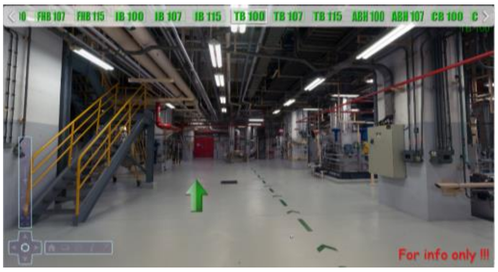
3.4(a) Good practice: Plant panoramic tour

The plant has implemented panoramic tour using photos of technological areas.

Multiple panoramic snapshots were made inside plant technological areas in different elevations of buildings. The tool is available for all workers with access to a plant computer.

There are several benefits provided by this software:
- Reduced time in the tagging process: operators can readily locate and identify specific equipment and area requirements;
- Software could be used during pre-job briefings for better explanation of field specific features to workers before going in the field to do the task;
- It enhances the ability for new plant workers in becoming familiar with the plant layout;
- Civil structures engineers during the storage of equipment approval process can efficiently evaluate requested storage space;
- Areas which are not readily accessible such as the containment at power can be reviewed and discussed immediately.

This results in reduced radiation dose and improves the efficient use of plant working time.



3.6. FIRE PREVENTION AND PROTECTION PROGRAMME

3.6(1) Issue: Some plant arrangements for control of combustible materials and fire response do not ensure efficient fire prevention and protection.

The team noted the following:

- In the area of plant arrangements and practices for evaluation, approval and control of combustible materials:
  - Formal training of the engineer responsible for evaluation and approval of combustible materials storage is not required;
  - The plant guidance to evaluate fire loads prior to approval of storage of materials is not in place;
  - Evaluation and approval of fire loads in non-technological areas (warehouse, construction sites etc.) are not considered in procedures;
  - The type and amount of approved storage combustible items is not posted at the storage locations;
  - A large drum continuing oil and a significant amount of cables related to a temporary modification were observed in the field without being mentioned in the temporary modification package. No special fire analysis had been made on the drum and cables;
  - Auxiliary building, elevation 94, room AB028. Combustible plastic stand inside of local warehouse was not evaluated and authorized (absent in storage request sheet);
  - Turbine hall, elevation 100, vicinity of the evacuation door labeled ‘R-3’. Unauthorized storage of equipment and wooden pallet;
  - Demineralization station. Three non-fireproof cabinets containing tools and a glass bottle of flammable liquid.
- In the area of fire response strategies:
  - Written guidance is not provided with requirements for development of fire fighting strategies;
  - The fire fighting strategy for fire area IB-12 (turbine-driven auxiliary feedwater pump room) has not been developed;
  - The plant has not developed fire fighting strategies for large fires affecting more than one fire area and for mobile diesel generators AE900DSL001, 002, 003;
  - Fire fighting strategies for areas AB-5, AB-6 (residual heat removal heat exchangers) are included in the strategy for the bigger area – AB-2(z), masking the specific fire fighting actions required for this area. Also fire fighting strategies for these areas have no clearly defined access routes for the fire brigade;
  - Mobile diesel generators AE900DSL001, 002, 003 have no fire detection and fire suppression systems.

Without comprehensive plant arrangements for control of combustible materials and fire strategies safe plant conditions and prompt response to fire cannot be ensured.

Recommendation: The plant should enhance arrangements for control of combustible materials and fire response to ensure efficient fire prevention and protection.

IAEA Bases:

SSR-2/2 Rev.1

Requirement 22: Fire safety

The operating organization shall make arrangements for ensuring fire safety.

5.21. The arrangements for ensuring fire safety made by the operating organization shall cover the following: adequate management for fire safety; preventing fires from starting; detecting and extinguishing quickly any fires that do start; preventing the spread of those fires that have not been extinguished; and providing protection from fire for structures, systems and components that are necessary to shut down the plant safely. Such arrangements shall include, but are not limited to:

(b) Control of combustible materials and ignition sources, in particular during outages.

5.24. The operating organization shall be responsible for ensuring that appropriate procedures are in place for effectively coordinating and cooperating with all firefighting services involved. Periodic joint fire drills and exercises shall be conducted to assess the effectiveness of the fire response capability.

NS-G-2.1

6.1. Administrative procedures should be established and implemented for effective control of combustible materials throughout the plant. The written procedures should establish controls for delivery, storage, handling, transport and use of combustible solids, liquids and gases. Consideration should be given to the prevention of fire related explosions within or adjacent to areas identified as important to safety. For areas identified as important to safety, the procedures should establish controls for combustible materials associated with normal plant operations and those which may be introduced in activities related to maintenance or modifications.

6.2. Written procedures should be established and enforced to minimize the amount of transient (i.e. non-permanent) combustible materials, particularly packaging materials, in areas identified as important to safety. Such materials should be removed as soon as the activity is completed (or at regular intervals) or should be temporarily stored in approved containers or storage areas.

6.3. The total fire load due to combustible materials in each area identified as important to safety should be maintained as low as reasonably practicable, with account taken of the fire resistance rating of the compartment boundaries. Records should be maintained that document the estimated or calculated existing fire load as well as the maximum permissible fire load in each area.

6.5. Administrative controls should be established and implemented to ensure that areas important to safety are inspected periodically in order to evaluate the general fire loading and plant housekeeping conditions, and to ensure that means of exit and access routes for manual fire fighting are not blocked. Administrative controls should also be effected to ensure that the actual fire load is kept within permissible limits.

8.1. A fire fighting strategy should be developed for each area of the plant identified as important to safety (including those areas which present a fire exposure risk to areas important to safety). These strategies should provide information to supplement the information provided in the general plant emergency plan. The strategies should provide all appropriate information needed by fire fighters to use safe and effective fire fighting techniques in each fire area. The strategies should be kept up to date and should be used in routine classroom training and in actual fire drills at the plant. The fire fighting strategy developed for each fire area of the plant should cover the following:

- Access and exit routes for fire fighters;
- Locations of structures, systems or components identified as important to safety;
- Fire loadings;
- Particular fire hazards, including the possible reduced capability for fire fighting due to external events;
- Special radiological, toxic, high voltage and high pressure hazards, including the potential for explosions;
- The fire protection features provided (both passive and active);
- Restrictions on the use of specific fire extinguishing agents because of concerns about nuclear criticality or other particular concerns, and the alternative extinguishing media to be used;
- Locations of heat and/or smoke sensitive components or equipment important to safety;
- Location of fixed and portable extinguishing equipment;
- Water supplies for manual fire fighting;
- Communication systems (not affecting safety systems) for use by fire fighting personnel.

8.2. Plant documentation should provide a clear description of the manual fire fighting capability provided for those areas of the plant identified as important to safety. The manual fire fighting capability may be provided by a suitably trained and equipped on-site fire brigade, by a qualified off-site service or by a coordinated combination of the two, as appropriate for the plant and in accordance with national practice.

(d) The need to ensure that the individual who is responsible for the review of planned design changes and plant modifications is sufficiently knowledgeable to recognize issues that may have implications for fire protection features; this necessitates detailed knowledge of the design and testing requirements of hardware for fire protection and knowledge of specific design objectives for fire protection features in each fire area of the plant, as specified in the fire hazard analysis or similar documentation;

(e) Training for personnel who may initiate or authorize work activities involving hot work and staff who may be assigned the duties of a fire watch, to ensure that they are made aware of the hazards associated with activities such as cutting and welding which could produce a potential ignition source.

NS-G-2.14

4.36. Factors that should typically be noted by shift personnel include:

- Deviations in fire protection, such as deterioration in fire protection systems and the status of fire doors, accumulations of materials posing fire hazards such as wood, paper or refuse and oil leakages, or industrial safety problems such as leakages of fire resistant hydraulic fluid, hazardous equipment and trip hazards.

4. MAINTENANCE

4.1. ORGANIZATION AND FUNCTIONS

Prior to opening a Work Order shift supervisor always instructs maintenance personnel on work site safety precautions. The team observed that in some cases a questioning communication between shift supervisor and maintenance crew is missing. Preparation of maintenance work sites is inspected jointly by operations and maintenance personnel before opening the work order. The team encourages the plant to stimulate questioning communication between shift supervisors and maintenance crews e.g. safety precaution briefing and prompt identification of deficiencies in the field.

4.2. MAINTENANCE FACILITIES AND EQUIPMENT

Some plant practices in maintaining storage standards in warehouses and local storage areas do not always provide appropriate conditions for personnel and plant safety. The team has made a suggestion in this area.

The team observed some deficiencies concerning measurement and testing equipment calibration and control. Accuracy and traceability of this equipment are not ensured. The team has found some weaknesses in some tools (caliper-gauges, micrometers and tape-measures) found without a calibration sticker or the stickers are dated more than three years ago. The team encourages the plant to control calibration and ensure accuracy and traceability of the measurement and testing equipment.

4.6. MATERIAL CONDITION

The team has found some facts concerning inadequate fastening of flanges, painted bolts and missing bolts. The team encourages the plant to establish clear policies and expectations regarding bolting to ensure good material condition and lower the risk of damage of equipment and injury to personnel.

The team observed some weaknesses concerning foreign material exclusion (FME) such as: the posted sign for a FME area was obstructed by the FME helmet storage rack; in some cases improper materials were used as plugs or covers. The team encourages the plant to continue with improving in this area.

4.8. SPARE PARTS AND MATERIALS

Addressing technological obsolescence, the plant has implemented 3D printing (a new additive technology) to produce some spare parts directly from design data or even in a case when specifications are not available. The team recognized this as a good practice.

DETAILED MAINTENANCE FINDINGS

4.2. MAINTENANCE FACILITIES AND EQUIPMENT

4.2(1) Issue: Some plant practices in maintaining storage standards in warehouses and local storage areas does not always provide appropriate conditions for personnel and plant safety.

The team noted the following:

- Electrical tools and spare parts were stored directly on the floor in the maintenance local warehouse.
- Broken or non-calibrated tools were mixed and stored together with the good ones in the maintenance workshop.
- In the maintenance local warehouse tools and instruments were found stored over a machine and electrical cabinet.
- Equipment manuals and other documentation in the local warehouse were found on the top of cabinets due to lack of designated storage place.
- Ropes for common use were found stored with those used for special lifting and rigging activities. The ropes do not have labels or testing stickers to prevent accidental use.
- In the Maintenance Building some equipment was found stored on a movable platform without engaged brakes to prevent uncontrolled movement.
- In the Maintenance Building two 150 liter liquid nitrogen vessels and one smaller container found stored outside the warehouse due to lack of space. The storage place is not labelled as per plant expectations.
- In the Maintenance building (electrical part room) two rolling bearings /SKF 7232/ were found stored under the stairs.

Without adequate storage standards in the warehouse and local storage areas the safety of personnel and condition of important plant equipment could be put at risk.

Suggestion: The plant should consider reinforcing its practices for maintaining storage areas to provide appropriate conditions for personnel and plant safety.

IAEA Bases:

SSR-2/2 Rev.1

Requirement 28:

The operating organization shall develop and implement programmes to maintain a high standard of material conditions, housekeeping and cleanliness in all working areas.

7.10 Administrative controls shall be established to ensure ….. and that temporary storage is controlled and limited.

8.17 The operating organization shall ensure that storage conditions are adequate and that materials (including supplies), spare parts and components are available and are in proper condition for use.

NS-G-2.6

8.32. The operating organization should ensure that storage facilities offer adequate space and provide for the secure retention of stocks in suitable environmental conditions, in order to prevent deterioration. Access and the installed handling equipment should be adequate for the types and sizes of items to be stored.

4.8. SPARES PARTS AND MATERIALS

4.8(a) Good practice: Reverse-engineered and additive technology, (3D printing).

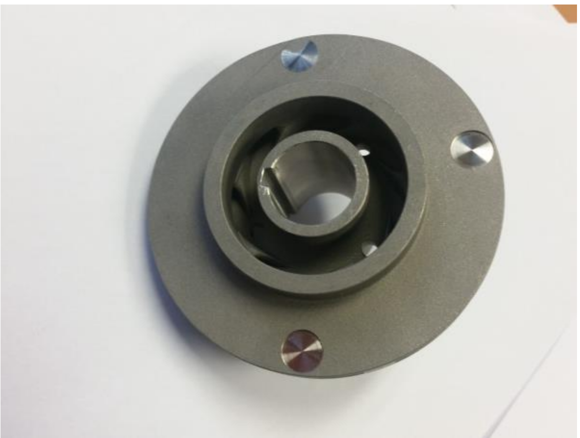
The plant has, together with a vendor, reverse-engineered and produced an impeller for a Fire Protection Pump.

Drawings were unavailable which is why the reverse-engineering with laser scanning was performed. The lead time was reduced by approximately 50 percent for both the engineering and manufacturing lead time. This method may benefit other plants because it enhances of replacements of important components in a timely manner, reducing the time that equipment is out of service because of lack of spare parts.

The manufacturing of the impeller was performed by using lasers to fuse together high-performance materials layer by layer, (3D printing).

Stringent quality and safety assurance requirements required extensive testing that was performed jointly by the vendor and the plant, over several months, ensuring that the new 3D-printed part would perform safely and reliably.

The stainless steel 108mm diameter impeller for a Fire Protection Pump made with new additive technology (3D printing) has been in operation since January 2017. The plant implemented quality requirements to the part to get high quality product with all documentation. The original impeller had been in operation since the plant commissioning.



5. TECHNICAL SUPPORT

5.2. PERIODIC SAFETY REVIEW

The scope of the second Plant Periodic Safety Review (PSR) programme has been defined based on National Regulations and IAEA Safety Standards that includes review of 15 PSR safety factors. The programme has defined the review objectives, methodology and schedule, and has been duly agreed with the regulatory body. The team noted that the PSR documentation was complete and well structured. As a result of PSR a detailed report and implementation action plan has been produced. The implementation action plan has clearly established categorization, prioritization and resolution of the review findings providing for their proper planning and implementation. The team recognized this as a good performance.

5.7. PLANT MODIFICATION SYSTEM

The plant has a very comprehensive and well-established process for management of the permanent modification. To minimize misalignment of newly installed plant systems and equipment with the existing ones or new modifications to the existing systems an efficient tool has been introduced. 3D modelling of plant systems, structures and components have been done using 3D laser scanning and existing plant documentation. By utilizing this tool, the need for later design and configuration related corrections are avoided. The team recognized this as good performance.

The plant has adopted an efficient approach to ensure effective management of the design changes and subsequent smooth transfer of the modification ownership during the handover to operations by engaging and ensuring active participation of different plant organisations, such as Maintenance, Operations, QA/QC, Licensing and Engineering Support organisations in the project team for modification. The Design Change Department has been introduced as a Design Authority to be responsible for coordination of the whole modification process from its initiation through to its close-out. The team considers this as good performance.

The plant utilizes a formalized process for temporary modifications management and the control over the temporary modifications at different levels is deployed. However, the team observed that the control measures applied are not fully effective to ensure their limitation in time and in number. The team made a suggestion in this area.

Changes to the plant physical configuration are well communicated and controlled using MECL database. Information from several plant systems are used to timely update equipment configuration related data and to properly maintain this database. Nevertheless, the team noted that some components of the configuration management process are not still implemented, such as definition of the configuration baselines, conduct of configuration audits and preparation of configuration status accounting reports. The team encourages the plant to continue its efforts and to formalize the missing steps of the process.

DETAILED TECHNICAL SUPPORT FINDINGS

5.7. PLANT MODIFICATION SYSTEM

5.7(1) Issue: Management control of temporary modifications is not fully effective in limiting the duration and number of temporary modifications to minimize the possible adverse impact on safety.

During the review, the team observed the following:

- The plant second Periodic Safety Review implementation plan includes a corrective action (cat. I) that requires a survey of temporary modifications and resolution of the modifications during the outage (4.3-23). The performance target for open temporary modifications is too low compare with the plants ability to achieve it and that is why it was constantly red. The indicator has been revised and the action was closed on 21.1.2015, however two indicators related to temporary modifications are currently red. The two performance indicators are:
  - ‘Number of open temporary modifications’ (last status dated 03.05.2017 - 38 temporary modifications)
  - ‘Number of unresolved temporary modifications after outage’ (last status dated 17.11.2016 - 26 temporary modifications)
- Temporary modifications do not have deadlines for removal, though an expectation has been set that this is no longer than 6 months.
- There are a total of 36 temporary modifications identified in the list provided by the plant and 25 temporary or conditionally installed parts or components according to respective KPI (last status dated 06.04.2017), 26 of the 36 temporary modifications have been in place longer than 6 month.
- In the Temporary modifications log in the MCR the type of temporary modifications is not consistently marked (appendix 6.3. of ADP-1.1.301 Rev5).

Without effective control of temporary modifications the safety of the plant may be affected.

Suggestion: The plant should consider enhancing the effectiveness of temporary modifications control to ensure their limitation in time and in number to minimize of the possible adverse impact on safety.

IAEA Basis:

SSR-2/2 Rev.1

4.41. Temporary modifications shall be limited in time and number to minimize the cumulative safety significance. Temporary modifications shall be clearly identified at their location and at any relevant control position. The operating organization shall establish a formal system for informing relevant personnel in good time of temporary modifications and of their consequences for the operation and safety of the plant.

NS-G-2.3

6.3. The number of temporary modifications should be kept to a minimum. A time limit should be specified for their removal or conversion into permanent modifications.

6.5. The plant management should periodically review outstanding temporary modifications to consider whether they are still needed, and to check that operating procedures, instructions and drawings and operator aids conform to the approved configuration. The status of temporary modifications should be periodically reported (typically at monthly intervals) to the plant manager. Those that are found to be needed permanently should be converted in a timely manner according to the established procedure.

6. OPERATING EXPERIENCE FEEDBACK

6.1. ORGANIZATION AND FUNCTIONS

Analysis and corrective actions of plant condition requests are not always being completed by their assigned due dates to ensure deficiencies are corrected in due time to avoid any recurrence of the events. The team noted a considerable number of corrective action programme analysis and assignments had either been rescheduled or not completed by their established due dates. The team made a recommendation in this area.

The currently plant uses one Corrective Action database to identify operating experience along with all other direct actions (work requests, scheduled documentation revisions, etc) which may make it more difficult to prioritize actions. The team encouraged the plant to develop a way to more clearly delineate which condition requests are as a result of internal and external Operating Experience in order to prioritize their actions.

The plant requires staff who conduct Root Cause Analysis (RCA) and Apparent Cause Evaluations (ACE) to complete training on Human Performance and Root Cause Analysis and Trending. However, due to the low number of RCA and ACE performed each year, it is likely that staff could take the training and then not perform one of these evaluations for years. The team encouraged the plant to consider establishing requalification training at an appropriate periodicity.

The plant has paid a lot of attention to the review of industry operating experience. External OE is widely and consistently used in the plant, in areas such as:

- Pre-job briefs;
- System Health Reports;
- Apparent and Root Cause Analysis;
- Work Ordering planning and execution;
- Modification Process;
- Ageing Management Programme;
- Training.

Supporting this is an internally developed search application (named IZI) that provides staff with the ability to easily search for Operating Experience. Only one search is needed to get results from various internal and external applications/databases/documents. This saves time and encourages users to search for OE while preparing for work identified above. The team considered this as a good performance.

6.8. TRENDING AND REVIEW OF OPERATING EXPERIENCE

The team observed that the Corrective Action Programme is not being fully utilized to conduct trending and/or record adverse trends. Subsequently, analysis and development of improvement plans is not being conducted to drive continuous improvement in a timely manner. The team made a suggestion in this area.

DETAILED OPERATING EXPERIENCE FINDINGS

6.1. ORGANIZATION AND FUNCTIONS

6.1(1) Issue: The plant does not ensure the timely analysis of plant condition requests and completion of corrective actions to minimize the risk from recurrence of events.

The team noted the following:

- 26% of the plant Corrective Action Programme event analyses have been rescheduled;
- 38% of the plant Corrective Action Programme event assignments have been rescheduled;
- 20 of the plant Corrective Action Programme event analysis have not been completed by their due date and have not been extended as expected by plant procedures;
- 109 of the plant Corrective Action Programme event assignments have not been completed by their due date and have not been extended as expected by plant procedures;
- 460 of the plant Direct Assignments have not been completed by their due date and have not been extended as expected by plant procedures;
- February 16, 2017 Reactor Scram due to Closing of the Main Feedwater Control Valve event root cause analysis due date was rescheduled due to one of the preliminary support actions not meeting it’s due date.

Without completing analysis and corrective actions within the appropriate time scales similar events may occur.

Recommendation: The plant should ensure the timely analysis of plant condition requests and completion of corrective actions to minimize the risk from recurrence of events.

IAEA Bases:

SSR 2/2 Rev 1
4.37. Progress in taking the corrective actions shall be monitored to ensure that actions are completed within the appropriate timescales.

5.30. As a result of the investigation of events, clear recommendations shall be developed for the responsible managers, who shall take appropriate corrective actions in due time to avoid any recurrence of the events.

GS-G-3.1
6.71. Senior management should ensure that corrective actions are subjected to approval, prioritized and completed in a timely manner on the basis of their significance. Managers should be held accountable for meeting due dates for corrective actions. Extensions or exceptions to due dates for completing corrective action should be controlled and should be made only in response to new issues of higher priority.
NS-G-2.11
5.7. A tracking process should be implemented to ensure that all approved corrective actions are completed in a timely manner…

6.8. TRENDING AND REVIEW OF OPERATING EXPERIENCE

6.8(1) Issue: Trending and common cause analysis of reported events, including low level events and performance indicator adverse trends is not fully implemented within the plant´s Corrective Action Programme.

During the review, the team observed the following:

- The corrective action programme was not used to record the trend and develop improvement plans for adverse trends in 11 yellow rated performance indicators that had performance below target consistently over the past 6 months. A few examples are:
  - Work Scope Stability Performance Indicator;
  - Number of Work Orders Planned 4 Weeks in Advance Performance Indicator;
  - Number of Temporary Installed Parts or Components Performance Indicator;
  - Number of Failures Discovered by Surveillance & Predictive/Preventative Maintenance Performance Indicator;
  - Number of Operations HU Events Performance Indicator
- Trend reports in accordance with NEK ADP 1.0.21 Trending were not developed for each department within the plant;
- Due to lack of trend reports, abnormal trends are not being analysed nor improvement plans developed in accordance with plant procedures;
- Plant self-assessments do not include a reviews of department trend reports

Without good trending and common cause analysis of all reported events, including low level events and adverse trends, flaws in the barriers in the organization, processes, procedures and human performance can remain undetected and preventive actions for continuous improvement will not be defined in a timely manner, before they lead to events with more serious consequences.

Suggestion: The plant should consider implementing a fully comprehensive system for trend, analysis and development of improvement plans within the corrective action programme.

IAEA Bases:

SSR 2/2 Rev 1
5.29 Information on operating experience shall be examined by competent persons for any precursors to, or trends in, adverse conditions for safety, so that any necessary corrective actions can be taken before serious conditions arise.

NS-G-2.11
6.10 Once an abnormal trend has been identified it should be treated as an event, and the established deficiency reporting programme should be used to initiate an appropriate analysis and to determine whether the trend is identifying adverse performance. The level of the analysis should be based on the significance of the trend and its potential consequences. A thorough root cause investigation can be made so as to identify causal and contributing factors to explain why a trend is occurring. Corrective actions should be focused on addressing the causes and should be incorporated in the organizations process or programme for corrective actions.

NS-G-2.4

6.66 Trending should identify recurring similar events and continued problems based on the causes and initiators of previous events. Event trend reviews and conclusive interpretations should be provided periodically to the plant manager and to the management of the operating organization.

7. RADIATION PROTECTION

7.3. RADIATION WORK CONTROL

A comprehensive system of radiological postings is implemented at the plant, however individual cases of shortfalls in the system use were observed. On several occasions the team observed radioactive material not posted when stored in the RCA. There were deficiencies in posting of contaminated areas. RP technicians were found knowledgeable and well trained, however individual examples of surveys execution, which did not meet the plant's expectation and would lead to inaccurate information on radiological conditions in an area, were observed by the team. The boundaries of radiation controlled areas (RCA) and supervised areas are in some cases being marked by radiation trefoil together with information about the dose rate near the boundary. Criteria defining the areas are specified in the radiation protection programme, however inconsistencies were observed in the criteria application. Furthermore the programme does not have a requirement to post all access points to the RCA. The team made a suggestion in this area.

An Area Radiation Monitoring (ARM) system, originally designed for outside use during normal operation and in case of emergency, has been adapted at the plant to also be used inside the RCA. This assures good knowledge of the system by the RP staff and provides an excellent overview of the system operability.

The system consists of:

- Self-powered dose rate probes;
- Portable dose rate measurement devices;
- Alpha/beta aerosol air monitors;
- Gamma spectrometer

Some dose rate detectors are used inside the rooms of the auxiliary building and in the containment building during outages. These include local alarms. The dose rate monitors are resistant to harsh environment and seismic conditions and cover the range of 10 nSv/h to 10 Sv/h.
All detectors are connected via a short-range wireless network to the central computer in the health physics office and also to the plant information system with access for operators in the main control room. During emergencies the signals from the detectors can be received in the emergency monitoring van. The team considered this as a good performance.

DETAILED RADIATION PROTECTION FINDINGS

7.3. RADIATION WORK CONTROL

7.3(1) Issue: The plant does not consistently provide workers with adequate information to ensure that they are fully aware of actual radiological conditions.

The team noted the following:

- Near a main entry to the radiation controlled area a label ‘Entry to RCA’ is posted. There are no specific labels dedicated to designate radiation controlled area or supervised area;
- A transportation door in the Decontamination building did not have the RCA border posting on either side (RCA and outside). According to the plants expectation only doors giving access to areas with dose rate higher or equal to 0,5 microSv/hour should be posted;
- A contaminated vacuum cleaner (dose rate 5 microSv/hour contact) stored under a notice stating ‘Low radiation spot’ without any label;
- A cart with stored pieces of pipes was found stored in the Decontamination building without any labels. The RP technicians considered the storage as clean, however, the measurement identified it was radioactive (7 microSv/hour) and contaminated;
- The cart with pieces of radioactive pipes had been stored in the Decontamination building for several weeks. The area is surveyed weekly, however the presence of unlabeled contaminated equipment had not been identified during the surveys;
- In a contaminated area in the Decontamination building the level of contamination was not posted, this does not meet the plant radiation, protection expectation and written procedural requirements;
- The plant has a requirement to secure and post supervised areas where the dose rate is higher then 0,5 microSv/hour. One supervised area outside the RCA was found, where the barrier was installed at the dose rate of 1 microSv/hour, which is higher than the plant requirements. Later it was explained that an RP technician moved the barrier designating supervised area because of ongoing construction work;
- An evaluation of large area swipes performed by an RP technician led to incorrect contamination determination. The procedure was later reviewed and it was discovered that it was not specific enough to ensure the RP technicians deduce to the correct result;
- When performing a contamination survey an RP technician realised that a smear test device was faulty. He was not able to fully execute an alternative method of contamination assessment, although an alternative measurement device was available;
- Two IP-2 containers were found stored in a supervised area behind the decontamination building. It was stated that they contain radioactive materials, however the RP identified absence of radioactive materials and removed the posting and the barrier of the area.

Without adequate and consistent radiological information, workers might be unaware about actual radiological conditions in their work areas.

Suggestion: The plant should consider improving the adequacy and consistency of information about radiological conditions provided to workers.

IAEA Bases:

GSR Part 3

Requirement 24:

Employers, registrants and licensees shall establish and maintain organizational, procedural and technical arrangements for the designation of controlled areas and supervised areas, for local rules and for monitoring of the workplace, in a radiation protection programme for occupational exposure.

3.90. Registrants and licensees:

(c) Shall display the symbol recommended by the International Organization for Standardization and shall display instructions at access points to and at appropriate locations within controlled areas.

(h) Shall periodically review conditions to assess whether there is any need to modify the measures for protection and safety or the boundaries of controlled areas;

(i) Shall provide appropriate information, instruction and training for persons working in controlled areas.

3.94. Employers, registrants and licensees, in consultation with workers, or through their representatives where appropriate:

(d) Shall ensure that any work in which workers are or could be subject to occupational exposure is adequately supervised and shall take all reasonable steps to ensure that the rules, procedures, and measures for protection and safety are observed

NS-G-2.7

2.18. The process of optimization of protection in operation should begin at the planning stage and should continue through the stages of scheduling, preparation, implementation and feedback. This process of optimization through work management should be applied in order to keep exposure levels under review and to ensure that doses are as low as reasonably achievable [10, 11]. The management of the operating organization should be committed to implementing measures for radiation protection appropriately and to specifying the means available for such implementation. Guidance on the application of the principle of optimization is given in Section 3.

3.8. Warning symbols such as those recommended by the International Organization for Standardization (ISO) and appropriate information (such as radiation levels or contamination levels, the category of the zone, entry procedures or restrictions on access time, emergency procedures and contacts in an emergency) are required to be displayed at access points to controlled areas and specified zones and at other appropriate locations within the controlled area (Ref. [2], para. I.23). Persons crossing a zone boundary should be made aware immediately that they have entered another zone in which dose rates or contamination levels, and thus the working conditions, are different.

3.24. The main objectives of radiological monitoring and surveying are: to provide information about the radiological conditions at the plant and in specific areas before and during a task; to ensure that the zone designation remains valid; and to determine whether the levels of radiation and contamination are suitable for continued work in the zone.

3.31. The reliability of the monitoring for the assessment of external and internal doses depends on many factors, including: functional testing; periodic maintenance and performance testing of the instruments used for these measurements; the calibration methods; and the qualification of the staff involved. Likewise, the traceability of these measurements and the retrievability of dose assessments should be given appropriate consideration. An adequate quality assurance system should be implemented so as to confirm the validity of the results of the assessment.

NS-G-2.6

4.23. Procedures and work related documents should specify preconditions and provide clear instructions for the work to be done, and should be used to ensure that work is performed in accordance with the strategy, policies and programmes of the plant. The procedures and work related documents should be technically accurate, properly validated, verified and authorized, and they should be periodically reviewed. Human factors and the ALARA principle (to keep radiation doses as low as reasonably achievable) should be considered in the preparation of work instructions.

RS-G-1.1

5.39. Measurements related to the assessment or control of exposure to radiation and radioactive materials are described by the general term ‘monitoring’. Although measurements play a major part in any RPP, monitoring is more than simply measurement; it requires interpretation and assessment. The primary justification for measurement must therefore be found in the way in which it helps to achieve and demonstrate adequate protection, including implementation of optimization of protection. The main functions of the various forms of monitoring are discussed in this section. More guidance is given in the companion Safety Guides on dose assessment [3, 4].

5.40. Monitoring may provide important supplementary benefits in the fields of industrial or public relations — such as reassurance and motivation of the workforce — or of scientific investigation — such as data for epidemiological studies — or in providing information useful in the determination of liability in the event of the expression of adverse health effects in individual workers. These considerations may well affect decisions about the nature and extent of monitoring programmes, but they do not in themselves provide the primary justification for a monitoring programme for radiological protection. Despite its importance, monitoring is a technique for radiological protection; it is not an end in itself.

5.46. The design and implementation of a monitoring programme should conform to quality assurance requirements, to ensure that procedures are established and followed correctly, and that records are promptly made and correctly maintained. The equipment to be used in the monitoring programme should be suitable for the radiation type(s) and the form(s) of radioactive material encountered in the workplace. The equipment should be calibrated to meet appropriate standards. More detailed guidance is presented in related IAEA/ILO documents [3, 4, 17]

8. CHEMISTRY

8.2. CHEMISTRY PROGRAMME

The chemistry programme is implemented well, and high levels of performance will likely continue because of focused monitoring of system chemistry and personnel development activities. One exception is the control of iron transport to the steam generators during plant startup. A contributing factor is the increased feedwater flow that has occurred as a result of power uprates beginning in 2000. Long term steam generator health may be adversely affected if improvements in reducing iron transport are not implemented. The team made a suggestion in this area.

Chemistry personnel and engineers have not collaborated effectively on actions to monitor and quantify microbiologically influenced corrosion (MIC). The essential service water system is not monitored consistent with industry guidance, as deposits are not removed and tested for microbiologically influenced corrosion. This has likely contributed to through-wall failures in low flow regions of the piping. Monitoring and strategies to prevent MIC in low flow areas of the essential service water (ESW) system have not been reviewed since 2009 even though additional industry guidance became available in 2012. The current station strategy to address MIC in the low flow areas of the ESW does not include monitoring to determine the extent of degradation from MIC. Monitoring and mitigation of MIC could enhance ESW and fire protection piping preservation. The team made a suggestion in this area.

The plant chemists are able to continuously monitor chemical control effectiveness to preserve the health of plant materials. Over 50 continuous on-line chemistry analyzers are installed, which are highly reliable, properly maintained and sensitive. The continuous analyzers are connected to the power plant information system and continuously provide effective measurement of important chemistry parameters. The team considered this as a good performance.

Plant chemists are actively involved in providing initial training for licensed operators. The training includes: primary release of corrosion products (CRUD burst) and shutdown chemistry. Training has also been provided to nuclear fuels, radiological protection, and maintenance personnel. The team considers this as a good performance.

Chemistry technicians are experienced and demonstrate good fundamental knowledge and ownership of chemistry programmes. Four times a year the station undertakes intra-laboratory and inter-laboratory tests of radioactive and non-radioactive samples to identify analytical interference, improper calibration, analytical technique and instrument operation for performing analysis. All qualified technicians are included in the testing. The plant achieved top performer status in 10 of the last 33 tests. The team considered this as a good performance.

DETAILED CHEMISTRY FINDINGS

8.2. CHEMISTRY PROGRAMME

8.2(1) Issue: Corrective actions in response to increased iron transported to the steam generators on plant startup are not fully effective.

The team noted the following:

- Increased feedwater flow has occurred as an effect of power uprates beginning in 2000 and the transition to 18 month cycles since 2003 resulting in increased transport of iron to the steam generators specifically during plant startup;
- Secondary feedwater iron peak concentration exceeds 5 ppb during plant startup. Control of feedwater iron to below 5 ppb is the industry standard for PWRs and other reactors;
- Control of feedwater iron is not included in the plant specification for startup as it was not included in the vendor specification for replacement of the plant steam generators;
- Corrective action programme (CAP) requests have been issued and some analysis has been done, however benchmarking has been limited. Some corrective actions have been proposed through CAP but have not been completed.

Long term steam generator health may be adversely affected if improvements in reducing feedwater iron transport are not implemented.

Suggestion: The plant should consider reducing the transport of feedwater iron during plant startup.

IAEA Bases:

SSG-13

2.10 Managers and supervisors should routinely observe chemistry activities to ensure adherence to plant policies and procedures. Chemistry performance indicators should be trended, and preventive and/or corrective measures should be undertaken where necessary.

6.2. The objectives of a chemistry surveillance programme are:

(c) To detect and thus permit early corrective action for any abnormal chemistry condition before it becomes a consequence significant for safety;

7.4. In the case of deviations or anomalies in results, these should be checked and verified by a competent individual and proper and prompt corrective action should then be taken and documented.

7.8. Trends should be reviewed soon after data have been recorded, in order to identify problems that may need corrective action before a parameter exceeds its specified limit. Trending should also be used to evaluate transients of short duration caused by plant operational changes and slower long term changes occurring under stable plant conditions. Evaluation of slow changes may facilitate the prediction of when a change could become a significant safety problem.

8.2(2) Issue: Some raw water systems important to plant safety, specifically essential service water, circulating water and fire protection are not sampled and analysed for microbiologically influenced corrosion (MIC).

The team noted the following:

- Algae, bacteria (known to cause MIC and under deposit corrosion) and sediments (silting) are fouling the essential service water.
- In April 2016, independent laboratory analysis confirmed the presence of general corrosion, accelerated by MIC, in an elbow with a thru-wall failure downstream of the component cooling heat exchanger. Prior to 2016, sampling and analyses for MIC had not been performed for the non-safety and safety related service water system and for the fire protection piping.
- In April 2009, microbiological analyses were performed by Biotehniska fakulteta, Ljubljana. The conclusion was that the potential for MIC is low; however the recommendation is for periodic verification.
- Service and fire protection system flow velocities are low thus creating a favorable environment for settling of sediments in the SW and fire protection systems and promotes environmental conditions for MIC and under deposit corrosion to become established.

Programmatic weaknesses in microbiologically-induced corrosion (MIC) monitoring can increase the risk of corrosion and through wall leaks in raw water and fire protection systems**.**

Suggestion: The plant should consider adopting industry monitoring practices regarding MIC to limit the potential for degradation of safety related raw water systems.

IAEA Bases:

SSR-2/2 Rev.1

Requirement 29:

The operating organization shall establish and implement a chemistry programme to provide the necessary support for chemistry and radiochemistry areas.

7.14. Chemistry surveillance shall be conducted at the plant to verify the effectiveness of chemistry control in plant systems and to verify that structures, systems and components important to safety are operated within the specified chemical limit values.

SSG-13

3.4. In the chemistry programme, it should be ensured that:

(d) The chemistry programme for auxiliary systems is in accordance with the material intent to preserve their full integrity and availability.

9. EMERGENCY PREPAREDNESS AND RESPONCE

9.1 ORGANIZATION AND FUNCTIONS

The team observed that the Urgent Protective Action Planning Zone (UPZ) covers an area close to the border with Croatia, and the Long Term Protective Action Planning Zone (LTPZ) partially covers an area within Croatian territory. This particular situation requires special arrangements for coordination on the issuance and adoption of protective action recommendations in the planning zones to ensure that the protection strategy is implemented consistently throughout all potentially affected areas. It was noted that the plant has not benchmarked its arrangements against best practices known and adopted in countries with similar planning zone configurations to ensure that protective action recommendations issued warranted according to actual emergency conditions off-site can be coordinated and consistently implemented by the corresponding authorities. The team made a suggestion in this regard.

9.2 EMERGENCY RESPONSE

It was noted that the plant organization participates actively in the protection of the public in the emergency planning zones at the preventive stage by pre-delivering iodine tablets and implementing a public information programme which includes periodical releases of useful information and organization of visits to the plant and education facilities. This practice demonstrates a proactive attitude towards safety and protection of the public, and allows a more efficient implementation of off-site protective actions in case of emergency. The team considered this as a good performance.

It was also noted that the plant organization has enhanced the capability for off-site radiological monitoring by using plant-specific dose assessment software, which is fed on-line with meteorological data and uses the Lagrange Particle Model to calculate accurate dispersion factors for site specific characteristics, and having available a mobile laboratory for quick sample analysis. The plant considers that this enhanced capability, which includes a prognosis application, allows a more accurate and prompt estimation of off-site radiological consequences, in support of the issuance of protective action recommendations for the public. The team considered this as a good performance.

It was noted that the site alarms do not identify the emergency level and the corresponding protective actions to adopt by all personnel. Therefore, the team encouraged the plant to enhance the arrangements for on-site notification of an emergency.

It was also noted that the current documentation control and management system does not distinguish the implementing procedures from the maintenance procedures for the emergency plan. The team encouraged the plant to implement a system that clearly state the applicability of each procedure, and avoid having non-applicable information in any of them.

9.3 EMERGENCY PREPAREDNESS

There are two hand-operated systems in the Operational Support Center (OSC) to provide ventilation and lighting, respectively. The system for ventilation is a pump whose intake comes from the outside, through sand which provides filtering. The system for lighting is a dynamo that supplies power to a network of light bulbs. This capability heps maintain habitability of the OSC in the long term, enabling enhanced protection arrangements for on-site personnel, including emergency responders. The team recognized this as a good performance.

The team observed that the Emergency Response Organization (ERO) is not staffed in accordance with a predefined pattern and that all personnel filling each position in the ERO are activated and mobilized at the same time. The current approach does not allow prioritizing the activation of human resources, and may cause the unnecessary exposure of workers to hazards during mobilization and an eventual evacuation. In addition to this, the current arrangements for managing the ERO rely on the coordination of all personnel able to fill each position to ensure the corresponding function is always covered. Some positions are assigned to different emergency response facilities on-site and off-site. This approach implies the need for certain ERO personnel to relocate from one facility to the other during the emergency, with additional associated risks. The team made a suggestion in this regard.

It was noted that practices for maintenance of emergency equipment are not always consistent with the requirements stated in plant procedures. Maintenance activities have not been performed at the frequency stated in the plant procedures in order to ensure availability, operability and functionality. The tools for checking and monitoring compliance with the maintenance programme can be improved. Some portable equipment, intended for accident management, is not stored in the most efficient way to ensure availability and minimize deployment time in the event of an emergency involving inaccessibility to large areas or extensive damage. The team made a suggestion in this regard.

DETAILED EMERGENCY PREPAREDNESS AND RESPONSE FINDINGS

9.1. ORGANIZATION AND FUNCTIONS

9.1(1) Issue: The plant has not benchmarked its protective actions, defined in the On-site Emergency Response Plan, covering all potentially affected areas within the emergency planning zones, to ensure protective action recommendations are coordinated.

The team noted the following:

The Long Term Protective Action Planning Zone covers Croatian as well as Slovenian territory. However:

- Direct notification of an emergency to the Croatian authorities is not foreseen in the On-site Emergency Plan;
- Protective action recommendations to adopt in Croatian territory are not foreseen in the On-site Emergency Response Plan;
- Krsko NPP does not possess a copy of the Croatia Emergency Response Plan;
- The National Emergency Response Plan for Slovenia does not explicitly include responsibilities of Croatian authorities in emergency response, nor coordination arrangements between organizations in each state;
- Potential protective actions to be adopted within the long term emergency planning zone in Slovenian and Croatian territories are not fully aligned.

Without having protective actions that cover all potentially affected areas within the emergency planning zones, protective action recommendations may not be coordinated and fully effective.

Suggestion: The plant should consider benchmarking its arrangements for issuance of protective actions recommendations against the arrangements at plants in similar geographical circumstances to ensure that emergency plan allows a coordinated protection strategy within all potentially affected areas.

IAEA Bases:

GSR Part 7

Requirement 5:

The government shall ensure that protection strategies are developed, justified and optimized at the preparedness stage for taking protective actions and other response actions effectively in a nuclear or radiological emergency.

4.30. The government shall ensure that interested parties are involved and are consulted, as appropriate, in the development of the protection strategy.

Requirement 6:

The government shall ensure that arrangements are in place for operations in response to a nuclear or radiological emergency to be appropriately managed.

5.9. For facilities in category I or II and areas in category V, arrangements shall be made for coordinating the emergency response between response organizations (including those of other States) within the emergency planning zones and emergency planning distances and for providing mutual support.

Requirement 7:
The government shall ensure that arrangements are in place for the prompt identification and notification of a nuclear or radiological emergency and for the activation of an emergency response.

5.21. Arrangements shall be made for promptly and directly notifying any State within the emergency planning zones and emergency planning distances within which urgent protective actions and early protective actions and other response actions could be required to be taken.

Requirement 22:
The government shall ensure that arrangements are in place for the coordination of preparedness and response for a nuclear or radiological emergency between the operating organization and authorities at the local, regional and national levels, and, where appropriate, at the international level.

Requirement 23:
The government shall ensure that plans and procedures necessary for effective response to a nuclear or radiological emergency are established.

6.17. Each response organization shall prepare an emergency plan or plans for coordinating and performing their assigned functions as specified in Section 5 and in accordance with the hazard assessment and the protection strategy. An emergency plan shall be developed at the national level that integrates all relevant plans for emergency response in a coordinated manner and consistently with an all-hazards approach. Emergency plans shall specify how responsibilities for managing operations in an emergency response are to be discharged on the site, off the site and across national borders, as appropriate. The emergency plans shall be coordinated with other plans and procedures that may be implemented in a nuclear or radiological emergency, to ensure that the simultaneous implementation of the plans would not reduce their effectiveness or cause conflicts.

SSR-2/2 Rev.1

Requirement 18:
The operating organization shall prepare an emergency plan for preparedness for, and response to, a nuclear or radiological emergency.

5.3. The operating organization shall develop an emergency plan and shall establish the necessary organizational structure, with assigned responsibilities for managing an emergency, and shall contribute to the development of off-site emergency procedures.

5.4. The emergency plan shall cover all activities under the responsibility of the operating organization and it shall be adhered to in the event of an emergency. The emergency plan shall include arrangements for an emergency involving a combination of non-radiological hazards and radiological hazards, such as a fire in conjunction with significant levels of radiation or contamination, or toxic or asphyxiating gases in conjunction with radiation or contamination.

Account shall be taken in the emergency plan of the specific site conditions. Preparation of the emergency plan shall be coordinated with those bodies having responsibilities in an emergency, including public authorities and private enterprises, as relevant, and the plan shall be submitted to the regulatory body as required. The plan shall be subject to review and updating in the light of experience gained.

9.3 EMERGENCY PREPAREDNESS

9.3(1) Issue: Arrangements for activation of the Emergency Response Organization do not ensure efficient and coordinated use of human resources so that the emergency response capability is maintained at all times.

The team noted the following:

- Emergency Response Organization staff are not pre-organised and all members of each function or position in the Emergency Response Organization are activated when the emergency level that triggers the activation of each position is declared;
- Following emergency escalation to level 2 or 3, the Emergency Operations Facility, located in Ljubljana, is activated in such a way that personnel filling the facility director position have to travel from the site to that facility. During the travel time, this person is not aware of the progress of the emergency conditions and response actions for at least one hour;
- Once activated, the Emergency Operations Facility Director assumes responsibility for emergency classification and issuance of protective action recommendation off-site, but the emergency direction function is kept by the person leading the Technical Support Center, which is on-site;
- According to emergency implementing procedures, the Emergency Director is responsible for decision making on deployment of response actions on-site, while the Emergency Operations Facility Director is responsible for decision making on allocation of resources for emergency response on-site;
- Emergency Response Organization personnel are required to notify unavailability for activation but there is no explicit requirement in procedure on how much time in advance;
- Personnel filling the same position in the Emergency Response Organization are instructed by procedure EIP-17.504 (PREIZKUŠANJE SKLICA OSEBJA V ORGANIZACIJI NEK ZA PRIMER ID, revision 5) to coordinate with each other to ensure the position is covered in the event of an emergency. However, if no agreement or coordination is achieved, they can still go into the management information system and notify unavailability for the same period. Although a warning appears in the system, this warning has to be checked by the Emergency Preparedness Coordinator but this task is not instructed explicitly in procedures;
- Certain positions in the ERO are assigned to both Technical Support Center (TSC) and Emergency Operations Facility (EOF), so that people filling these positions may need to move from one facility to the other during the emergency;
- The activation system does not prioritize notification of Emergency Response Organization staff based on confirmation of coverage for each function or position;
- The Rapid Reach System does not perform the second call-out to contact personnel who did not answer until the first call-out has been completed.

Without having arrangements for activation of the Emergency Response to assure an efficient and coordinated use of human resources, the plant's emergency response capability may be degraded.

Suggestion: The plant should consider revising the arrangements for activation of the Emergency Response Organization to ensure an efficient and coordinated use of emergency response organization resources, so that the emergency response capability is maintained at all times.

IAEA Bases:

GSR Part 7
Requirement 6:
The government shall ensure that arrangements are in place for operations in response to a nuclear or radiological emergency to be appropriately managed.

5.7. Arrangements shall be made for the establishment and use of a clearly specified and unified command and control system for emergency response under the all-hazards approach as part of the emergency management system. The command and control system shall provide sufficient assurance for effective coordination of the on-site and off-site response. The authority and responsibility for directing the emergency response and for making decisions on emergency response actions to be taken shall be clearly assigned. The responsibility for directing the emergency response and for decision making on emergency response actions to be taken shall be promptly discharged following a notification of an emergency.

Requirement 20:
The government shall ensure that authorities for preparedness and response for a nuclear or radiological emergency are clearly established.

6.4. The authority and responsibility for making decisions on response actions to be taken on the site and off the site and the authority and responsibility for communication with the public shall be clearly assigned for each phase of the response.

6.5. The emergency arrangements shall include clear assignment of responsibilities and authorities, and shall provide for coordination and for communication in all phases of the response. These arrangements shall include:

- Ensuring that for each response organization a position in the response hierarchy has the authority and responsibility to direct and to coordinate its response actions;
- Clearly assigning the authority and responsibility for the direction and coordination of the entire response (see para. 5.7) and for the prevention and resolution of conflicts between response organizations;
- Assigning to an on-site position the authority and responsibility for notifying the appropriate response organization(s) of an emergency and for taking immediate on-site actions;
- Assigning to an on-site position the responsibility for directing the entire on-site emergency response.

These arrangements shall be such as to ensure that those personnel with authority and responsibility to perform critical response functions in an emergency response are not assigned any other responsibilities in an emergency that would interfere with the prompt performance of the specified functions.

Requirement 21:

The government shall ensure that overall organization for preparedness and response for a nuclear or radiological emergency is clearly specified and staffed with sufficient personnel who are qualified and are assessed for their fitness for their intended duties.

6.10. Appropriate numbers of suitably qualified personnel shall be available at all times (including during 24 hour a day operations) so that appropriate positions can be promptly staffed as necessary following the declaration and notification of a nuclear or radiological emergency. Appropriate numbers of suitably qualified personnel shall be available for the long term to staff the various positions necessary to take mitigatory actions, protective actions and other response actions.

9.3(2) Issue: Maintenance and storage practices for equipment in emergency response facilities do not consistently ensure that the equipment is fit for emergency duty.

The team noted the following:

- Maintenance of emergency equipment in the Technical Support Center was not performed in 2015, based on the following observations:
- Maintenance was performed in 2014 and it was required to be performed at least every six months per procedure. However, no records exist of maintenance performed in 2015.
- Records from emergency equipment maintenance for the Technical Support Center in 2016 state explicitly that the previous maintenance was performed in 2014.
- Maintenance activities for emergency equipment were not performed at the frequency required per the procedure (per EIP-17.503, Emergency Equipment Inventory, revision 3) during 2016, as indicated in the corresponding records.
- The procedure for emergency equipment maintenance includes an item list that mixes frequencies for surveillance and performance of maintenance activities.
- The procedure for emergency equipment maintenance includes an item list that does not include equipment identification information for most of items.
- The procedure for emergency equipment maintenance (EIP-17.503) does not include a form or checklist to mark checked items and write down observations. The item list is used instead, including hand-written comments where space is available.
- Sealing devices to guard against tampering of equipment are not provided to avoid misuse of protective equipment stored in the Technical Support Center.
- There are pages extracted from uncontrolled procedure copies, unlabelled drawings and unlabelled information sheets (including hand-written additions and deletions) stuck on walls in the Technical Support Center, Operational Support Center, Emergency Operations Facility and Medical Facility.
- Long hoses are stored in shelves in a room outside the main storage area of the fire station. This location would result in delays in the deployment of the equipment.
- The Positive Displacement Pump for water injection into the reactor coolant system is stored outside (or in the Turbine Building, during cold seasons), since there is no space in the fire station for all equipment. This location does not ensure the required protection for this equipment.

Not adhering to plant maintenance and storage procedures may cause the unavailability or loss of functionality and usability of emergency equipment.

Suggestion: The plant should consider enhancing its maintenance and storage practices for equipment in emergency response facilities to consistently ensure that the equipment is fit for emergency duty.

IAEA Bases:

GSR Part 7
Requirement 24:
The government shall ensure that adequate logistical support and facilities are provided to enable emergency response functions to be performed effectively in a nuclear or radiological emergency.

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.

Requirement 26:
The government shall ensure that a programme is established within an integrated management system to ensure the availability and reliability of all supplies, equipment, communication systems and facilities, plans, procedures and other arrangements necessary for effective response in a nuclear or radiological emergency.

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.

SSR-2/2 Rev.1

5.7. Facilities, instruments, tools, equipment, documentation and communication systems to be used in an emergency, including those needed for off-site communication and for the accident management programme, shall be kept available. They shall be maintained in good operational condition in such a manner that they are unlikely to be affected by, or made unavailable by, accidents. The operating organization shall ensure that relevant information on safety parameters is available in the emergency response facilities and locations, as appropriate, and that communication between the control rooms and these facilities and locations is effective in the event of an accident [2]. These capabilities shall be tested periodically.

10. ACCIDENT MANAGEMENT

10.5. PLANT EMERGENCY ARRANGEMENTS WITH RESPECT TO SAM

The plant has implemented a programme for Severe Accident management including a Passive Containment Venting System, dikes, a structural wall to protect the plant against external flooding, upgrading the SAMGs and purchase of Severe Accident Management Equipment (SAME). However, during the review of the plant layout for the use of SAME, the team observed some shortfalls related to the timely moment of equipment to the designated plant locations and procedures for equipment use. This includes, for example, relocation of equipment to provide protection from flooding. The team made a suggestion in this area.

Regarding the emergency equipment, the team observed that a large fire pumper truck is available with boom/crane for directly reaching the spent fuel pool to provide spray water under adverse conditions, and it includes a software application for autonomous deployment and panels for remote control. This resource provides a highly reliable and readily available capability to prevent damage and mitigate consequences of accidents affecting the spent fuel pool. The team recognized this as a good performance.

DETAILED ACCIDENT MANAGEMENT FINDINGS

10.5. PLANT EMERGENCY ARRANGEMENTS WITH RESPECT TO SAM

10.5(1) Issue: The plant arrangements for use of Severe Accident Management Equipment (SAME) do not always ensure its availability for some of accidents.

The team noted the following:

- The recently constructed river water intake facility for mobile pumps is not equipped with doors in security fence. It could be used only if the security fence is cut. For this reason it hasn't been tested yet and can't be used during drills, instead two other water intakes are used. The doors are planned to be built-in as a part of ongoing modification of security system;
- Most of the SAMG related mobile equipment is stored in a building which is not flood protected to the same level as the Nuclear Island. In the very unlikely event of a Maximal Probable Flood (MPF) and an earthquake with magnitude greater than Design Basis Earthquake, the upstream and downstream embankments which protect the plant against MPF could fail, there is no evacuation plan nor dedicated place for relocation this mobile equipment.

Without proper arrangements for use of Severe Accident Management Equipment (SAME), the ability to respond to some of accidents cannot be assured.

Suggestion: The plant should consider improving the plant arrangements for use of Severe Accident Management Equipment (SAME).

IAEA Bases:

SSR-2/1
Requirements 8
Safety measures, nuclear security measures and arrangements for the State system of accounting for, and control of, nuclear material for a nuclear power plant shall be designed and implemented in an integrated manner so that they do not compromise one another.

SSR-2/2 Rev.1

Requirements 18
The operating organization shall prepare an emergency plan for preparedness for, and response to, a nuclear or radiological emergency.
5.7. Facilities, instruments, tools, equipment, documentation and communication systems to be used in an emergency, including those needed for off-site communication and for the accident management programme, shall be kept available. They shall be maintained in good operational condition in such a manner that they are unlikely to be affected by, or made unavailable by, accidents. The operating organization shall ensure that relevant information on safety parameters is available in the emergency response facilities and locations, as appropriate, and that communication between the control rooms and these facilities and locations is effective in the event of an accident [2]. These capabilities shall be tested periodically.

Requirement 19
The operating organization shall establish, and shall periodically review and as necessary revise, an accident management programme.

5.8C. The accident management programme shall include contingency measures, such as an alternative supply of cooling water and an alternative supply of electrical power, to mitigate the consequences of accidents, including any necessary equipment. This equipment shall be located and maintained so as to be functional and readily accessible when needed.

NS-G-2.15
2.20. If a decision is taken to add or upgrade equipment or instrumentation, the design specification of such equipment or instrumentation should be such as to ensure appropriate independence from existing systems and preferably appropriate margins with regard to the use of the equipment or instrumentation under accident and/or severe accident conditions. These margins should be such as to provide confidence or, where possible, to enable demonstration that the new equipment or instrumentation will function properly under the anticipated conditions. Where feasible, these conditions should be selected as the design conditions for the equipment under consideration. In that case, proper acceptance criteria for the equipment should be selected that are commensurate with the safety function of the equipment and the level of understanding of the severe accident processes.

3.69. For dedicated or upgraded equipment, there should be sufficient confidence in the equipment and, where possible, demonstration of its capability to perform the required actions in beyond design basis and severe accident conditions should be provided.

11. HUMAN TECHNOLOGY AND ORGANIZATION INTERACTION

11.3. CONTINUOUS IMPROVEMENT/LEARNING ORGANIZATION (MONITORING AND ASSESSMENT)

Ten years ago the plant began preparing for the retirement turnover that has begun and will continue for the next several years. At that time the plant hired many new people with the plan that these individuals would be fully-qualified and experienced when the current generation began to retire. This very long-range planning was considered by the team as a good performance.

The plant is making much progress in improving the Technology area of the HTO. There are major projects in progress to upgrade safety systems as well as many minor efforts including a ground-breaking initiative to use 3D printing to create obsolete parts.

There are also efforts to improve Human and Organization areas in the HTO. There are four focus areas that are targeted toward the H and O areas – Excellence in Human Performance, Leadership Expectations and Coaching, Excellence in Corrective Action Programme, and Work Process Effectiveness. There are action plans within the functional areas that are reported, by functional area, as a part of the regular reporting process. However, the team found that there is a lack of planning and integration, at the organization-wide level, of these Focus areas. This lack of integration is reducing the amount of progress in these focus areas. The team made a suggestion in this area.

DETAILED HUMAN TECHNOLOGY AND ORGANIZATION INTERACTION FINDINGS

11.3. CONTINUOUS IMPROVEMENT/LEARNING ORGANIZATION (MONITORING AND ASSESSMENT)

11.3(1) Issue: The station`s efforts to meet its own expectations for improvements in the management system – related to human performance, leadership coaching, and process improvement – are not sufficient to improve plant performance.

The team noted the following:

- Three of the four Focus Areas have not meet expectations for once a year. Three of the four Focus Areas have been focus areas for more than one year and are considered as long-term goals;
- There is no comprehensive plan that shows the scope of activities within the focus areas, the interactions between the different elements of the focus areas, milestone targets, and success measures for the focus areas;
- While typically there are good results when executing processes within particular functions, the results have not been as good with cross-functional processes such as procurement/purchasing and outage preparation and performance:
  - During the outage there was a valve that was improperly delivered and caused excessive seat leakage, so a new valve from the warehouse was installed in the system. This extended the outage by almost three days.
  - Some documents were not properly prepared prior to the outage which required additional work during the outage and resulted in unplanned overtime.
  - Prior to the outage it was not recognized that some system operability requirements would interfere or conflicts with other maintenance activities on the service water system, so some work needed to be rescheduled.
- Other examples of missing cross-functional coordination are:
  - Three of five access points to water for the emergency fire truck are blocked with a double row of security fencing.
  - A Radiation Protection technician did not notify the main control room as required by procedure after changing out a particulate filter and iodine canister on the Reactor Bldg. Vent Continuous Air monitor. The technician stated that the control room will know when the filter is replaced because an alarm will cease.
  - Access to an emergency stretcher obstructed by stored material and workplace fence.

A lack of continuous improvement leads to plant decline that may put the safety of personnel, plant equipment, and the public at risk.

Suggestion: The plant should consider reinforcing its efforts to meet its own expectations for improvements related to human performance, leadership coaching, and process improvement.

IAEA Bases:

GSR Part 2
Requirement 6
The management system shall integrate its elements, including safety, health, environmental, security, quality, human-and-organizational-factor, societal and economic elements, so that safety is not compromised.

4.8. The management system shall be developed, applied and continuously improved. It shall be aligned with the safety goals of the organization.

4.9. The management system shall be applied to achieve goals safely, to enhance safety and to foster a strong safety culture by:

(a) Bringing together in a coherent manner all the necessary elements for safely managing the organization and its activities;
(b) Describing the arrangements made for management of the organization and its activities;
(c) Describing the planned and systematic actions necessary to provide confidence that all requirements are met;
(d) Ensuring that safety is taken into account in decision making and is not compromised by any decisions taken.

4.10. Arrangements shall be made in the management system for the resolution of conflicts arising in decision making processes. Potential impacts of security measures on safety and potential impacts of safety measures on security shall be identified and shall be resolved without compromising safety or security [20–23].

GS-G-3.5

2.18. An organization should continually strive to improve its performance so that it does not become complacent. Complacency is often a precursor to a serious decline in safety culture. Management should establish processes and should show by individual example and direction that it expects individuals to look for ways to learn and improve with regard to safety. Operating experience should be highly valued and the capacity to learn from experience should be well developed. Training, benchmarking and self-assessment are often used to stimulate learning and to improve performance.

12. LONG TERM OPERATION

12.1. ORGANIZATION AND FUNCTIONS

The plant has developed a System Health Report for the Cable Ageing Management Programme. In the report, Personnel, Infrastructure, Implementation and Equipment are evaluated. The System Health Report is evaluated quarterly and graphically displayed for easy demonstration of programme status. The team has identified this as a good performance.

There are no specific performance indicators defined to show effectiveness of the whole Ageing Management Programme (AMP). AMP performance indicators will be established to completeness of the AMP actions during the last 5-year period before the transition to extended life-time. The team encouraged the plant to develop performance indicators show effectiveness, of the whole scope of activities performed to secure LTO.

12.2. SCOPING AND SCREENING, AND PLANT PROGRAMMES RELEVANT TO LTO

The plant performed several activities to secure safe long term operation (LTO) such as: plant safety upgrades, component replacements, an equipment reliability programme, an environmental qualification programme, an ageing management review according to US national requirements. The scoping for LTO was not uniform and not all steps have been consistently performed and documented. The team made a suggestion in this area.

12.3. REVIEW OF AGEING MANAGEMENT AND AGEING MANAGEMENT PROGRAMMES, AND REVALIDATION OF TIME LIMITED AGEING ANALYSES

In some Ageing Management Reviews (AMR) of commodity groups, some materials and/or intended functions were found to be handled in other commodity AMRs. No clear references are made in the AMR reports that the ageing management is handled in more than one AMR. The team encouraged the plant to ensure that all information and knowledge gathered in the Ageing Management project is documented and can be easily found.

Together with an external supplier, the plant has developed a Cable Ageing Management software Programme. Cable data (material, manufacturer, year of installation, inspections etc.), location, environment and qualification parameters are documented. It is possible to graphically trend measurements results, perform Risk Ranking and Calculation of residual lifetime. The team considered this to be a good performance.

The plant extends environmental qualified life to 60 years based on tests performed according to original standards, dated 1971 and 1974. For example, pre-ageing time to simulate qualified life (now 60 years) for motor operators (Limitorque) and penetrations (Westinghouse) in credited tests was 100h. The team encouraged the plant to not only rely on originally performed tests but also perform condition monitoring, analysis and tests of actual equipment to support the qualified lifetime assumptions.

The plants calculations for environmental qualified life are based on design environmental conditions rather than actual operational environmental conditions. Systematic hot spot identifications have been made, measurement programmes have been performed for potential hot spot areas/ components and the results have been incorporated. However no complete measurement programme to identify actual operation environmental conditions, including those areas without potential hot spots has been established. The team encouraged the plant to establish a comprehensive measurements programme to identify actual operation environmental conditions for all safety related components.

The plants EQ programme covers environmental qualification of Electrical and I&C components in a harsh environment. Mechanical and civil components are not included in the programme and the programme does not include environmental qualification of equipment in mild environment. The plant is encouraged to broaden the scope of the EQ programme to cover equipment qualification for all equipment, all areas and all environmental aspects.

The plant evaluation identified both open and closed position end switches of containment isolation valves to be environmentally qualified. The solenoid of the valve was not identified although it is electrically associated with the end switches. The plant is encouraged to perform evaluation of such components, associated with safety functions.

DETAILED LONG TERM OPERATION FINDINGS

12.2. SCOPING AND SCREENING, AND PLANT PROGRAMMESS RELEVANT TO LTO

12.2(1) Issue: The scope identified for Long Term Operation (LTO) is not complete and does not ensure that all relevant Systems, Structures and Components (SSCs) will be analyzed and adequately advised to ensure for safe LTO.

The team noted the following:

- In the Ageing Management Programme, project walk downs have not been performed systematically, to ensure that Non-Safety components Affecting Safety (NSAS), are included in the scope;
- Evaluation of active components was not included in the Ageing Management project, except those active components that are Environmentally Qualified (EQ) components and as such included in the Time Limited Ageing Analyses (TLAA) EQ revalidation;
- The plant has not used risk-based information to extend the scope for Ageing Management Review (AMR) in the Ageing Management project;
- Not all parts of the grounding system are included in the scoop for AMR in the Ageing Management project;
- Lightning protection Structures and Components (SCs) are not identified in the scope for AMR in the Ageing Management project;
- Not all civil electrical, items SCs are identified uniquely. The identification can be based on physical location or specific function;
- Not all TLAA listed in International Generic Ageing Lessons Learned (IGALL) are considered when establishing the scope of TLAA to be revalidated;
- Not all degradation effects documented in IGALL AMP204, Metal Enclosed Bus, are considered in AMR AMP-E-05, Bus Duct Commodity.

With an incomplete scope it cannot be demonstrated that the ageing management is adequate for the LTO.

Suggestion: The plant should consider verifying the scope identified for LTO is complete, analyzed and adequately addressed to ensure safe LTO.

IAEA Bases:

SSR-2/2 Rev.1

Requirement 16:
Where applicable, the operating organization shall establish and implement a comprehensive programme for ensuring the long term safe operation of the plant beyond a time-frame established in the licence conditions, design limits, safety standards and/or regulations.

4.54. The comprehensive programme for long term operation shall address:

(a) …;

(b) Setting the scope for all structures, systems and components important to safety;

(c) Categorization of structures, systems and components with regard to degradation and ageing processes;

(d) …

NS-G-2.12

6.3. The review process should involve the following main steps:

- An appropriate screening method to ensure that structures and components important to safety will be evaluated for long term operation;
- Demonstration that the effects of ageing will continue to be identified and managed for each structure or component during the planned period of long term operation;
- Revalidation of safety analyses that were developed using time limited assumptions, to demonstrate their continuing validity or that the ageing effects will be effectively managed, i.e. to demonstrate that the intended function of a structure or component will remain within the design safety margins throughout the planned period of long term operation.

6.5. The results of the review of ageing management for structures and components for long term operation should be documented.

15. USE OF PSA FOR PLANT OPERATIONAL SAFETY IMPROVEMENTS

15.1. ORGANIZATION AND FUNCTIONS

The plant Probabilistic Safety Assessment (PSA) is comprehensive and includes relevant Level-1 and Level-2 PSA scope. The scope appropriately includes internal initiating events, internal and external hazards and addresses both at-power and plant shutdown conditions. The Level-2 PSA is currently undergoing a revision to reflect the latest plant design changes including some analytical method changes. Additional analyses are also being conducted in certain areas, for example, the impact of combinations of hazards. The PSA is also maintained as a Living probabilistic safety assessment (LPSA) and updated on a yearly basis. The team considered this as good performance.

15.2. PSA PROJECT MANAGEMENT

The plant has established some novel practices that systematically assist in raising awareness of relevant staff on safety insights from the plant-specific PSA. This is being pursued through training on PSA methodology, where risk-related results/insights from the plant PSA are used for illustration purposes. Also, the practice is to communicate important information and relevant updates through the plant intranet and visual aids. The PSA reports updated yearly within the LPSA programme, are added to the intranet and notification of the issue of an updated report is sent to relevant staff. In addition, PSA results presented in easy-understandable form (such as pie and bar charts) are communicated widely using visual aids, such as in-plant information screens and posters. The team identified this as good practice.

Technical work related to PSA development/update and PSA applications is conducted mainly by the plant PSA team with periodic involvement of consultants. The tasks dealing with PSA development and review to be attended by the plant PSA team are numerous, and the level of complexity is high. The team encouraged the plant to consider optimizing resources for PSA-related work to maintain the good quality PSA programme.

The plant PSA model is developed as a comprehensive integrated Level-1 and Level-2 PSA model in commercially developed risk management software consisting of thousands of basic events and links between the events. Thorough knowledge of the complex model and effective skills to handle it currently rests primarily with a single person. The team encouraged the plant management to consider relevant knowledge management activities to ensure that the critical knowledge is preserved.

15.3. DEVELOPMENT OF PSA

The PSA documentation includes numerous reports and annexes, both hard copies and electronic files. It may be difficult to find reports by ordinary user. In order to facilitate navigation throughout the comprehensive documentation and PSA review, the team encouraged the plant to develop a consolidated list of contents of all PSA documentation with hyperlinks to specific reports covering different parts.

The plant LPSA programme envisages periodic review and update of the PSA on a yearly basis using newly collected data on operational experience and changes in the design and procedures. This is considered to be a standard practice. It should be noted that in addition to the update due to changes in the plant design and collected data on operational experience, a systematic periodic review of the whole plant PSA from the perspective of advancements in the PSA methodology is identified in the IAEA OSMIR database as a good practice. From the perspective of the PSA update to reflect advancements in the PSA methodology, it would be beneficial that the PSA team members systematically get an opportunity to be exposed to relevant information. Therefore, the team encouraged the plant to consider more active participation of the PSA team members in international conferences on PSA to build state-of-the-art knowledge that can be later applied for at the plant.

15.4. USE OF PSA IN PSA APPLICATIONS

A few inconsistencies were identified during spot checks of some parts of Level-1 and Level-2 PSA models and documentation that may potentially challenge the insights from PSA for some nuclear safety aspects. Though relevant general procedures are available, specific detailed plant procedures to conduct different PSA tasks (e.g. human reliability analysis, plant damage state definitions) and independent PSA review are currently missing. In addition, a few inconsistencies were identified during spot checks of some parts of the PSA related to introducing changes at the plant and modelling new systems. Such procedures covering as appropriate PSA development and independent review, as well carrying out plant-specific PSA applications and their review (e.g. use of PSA to support evaluation of design changes, risk-informed in-service inspections, operational events analysis, severe accident management) could ensure the quality of the plant PSA, PSA applications, and risk-informed decision-making. The team made a suggestion in this area.

Limitations applied in certain applications may affect risk metric estimates used in decision making. This is, for instance, the case for the application dealing with plant on-line configuration control during maintenance. Performing a comprehensive analysis of all actual corrective maintenance configurations along with other causes of components unavailability (e.g. temporary plant changes and preventive maintenance) from the viewpoint of evaluation of the cumulative impact on change in the applied risk metric estimates (e.g. core damage probability or instantaneous core damage frequency) is not within the scope of the present plant PSA application dealing with on-line maintenance. Extending the scope of the application to reflect all actual plant configurations may require deployment of other tools, e.g. acquisition and deployment of full-scope risk monitor software. The team encouraged the plant to explore the potential benefits of introducing the full-scope risk monitor.

A specific software tool is used and maintained by the PSA team to manage risk during maintenance while the plant is shutdown. However, currently the software tool is used only by the PSA team. The information on risk dealing with specific configurations is communicated to other departments in the form of reports. This doesn’t assist a prompt decision making. The team encouraged the plant to consider wider use of this tool by the other departments involved in planning and carrying out maintenance activities.

DETAILED USE OF PSA FOR PLANT OPERATIONAL SAFETY IMPROVEMENTS FINDINGS

15.2. PSA PROJECT MANAGEMENT

15.2(a) Good practice: Raising awareness of plant staff on insights from PSA

The plant has established good practices that assist in raising awareness of the staff on insights from the plant-specific Probabilistic Safety Assessment (PSA). This is being pursued through systematic training on PSA methodology and risk-related results/insights for nuclear safety, and wide communication of PSA results as described below:

- Training on PSA is provided within various training activities for the plant operational staff and engineers. In all training activities, the PSA team leader provides lectures and exercises on a full-scope Level-1 and Level-2 PSA methodology and PSA applications using real information from the plant-specific PSA for illustration purposes. The latest results of the plant-specific risk assessment are also presented in the training sessions;
- The plant practice is to promote communication of information to plant staff on PSA results/insights and relevant updates through the Intranet and visual aids. The updated PSA reports, which are produced yearly within the Living PSA programme, are put on the Intranet and a notification on the issue of an updated report is sent to all plant staff. In addition, PSA results; presented in a form that facilitate understanding (e.g. pie and bar charts) are communicated widely using visual aids, such as in-plant information screens and posters.

15.4. USE OF PSA IN PSA APPLICATIONS

15.4(1) Issue: The plant procedures and practices, which are deployed to carry out some PSA tasks/applications (e.g. modelling new systems) and to conduct independent PSA reviews, do not always ensure effective modelling and documenting of technical analyses within the PSA programme to ensure its consistency.

During the review the team identified the following:

- During a spot check of the Level-1 PSA model for Large Loss of Coolant Accident (LLOCA), it was found that several single-order minimal cutsets representing non-compliance with the single failure criterion for a design basis accident from the deterministic perspective are present in the PSA results. From the discussions with the counterpart, it was observed that an analysis of presence of single-order minimal cutsets in the PSA results was not systematically performed;
- Within a spot check of the Level-2 PSA model for the reactor vessel rupture event, it was found that the reactor vessel rupture was not grouped into the plant damage state in a fully consistent manner (crediting certain mitigating features without sufficient deterministic analysis); this may lead to underestimation of the contribution of internal initiating events to the overall Large Early Release Frequency (LERF);
- The use of ASME/ANS PRA Standard by the plant to support technical consistency of all PSA elements in the plant PSA model is not comprehensively documented;
- A dedicated PSA review procedure that would cover in detail all specific technical elements of the PSA and effectively assist in revealing inconsistencies is missing;
- Within a spot check, some inconsistencies were found in the newly developed model of

the drain system reliability. Specifically, Common Cause Failure (CCF) was not included in the Level-1 PSA model without a justification. In addition, the analysis of absence of potential for pre-accident human error (after introducing monthly tests of the check valves on the drain lines from the turbine building) was not documented. A dedicated specific procedure for the modelling of design changes that would help to minimize inadvertent mistakes in the PSA is missing.

Without specific detailed procedures for PSA development/applications and independent review, the technical consistency of the PSA and related risk-informed decisions dealing with some aspects of nuclear safety may be challenged.

Suggestion: The plant should consider enhancing its procedures and practices dealing with PSA development and application, as well as independent PSA review, to ensure higher consistency of PSA results and its' ability to serve as a robust tool to reliably support risk-informed decisions.

IAEA Bases:

GSR Part 4 Rev.1

5.8. The results of the safety assessment shall be used to make decisions in an integrated, risk informed approach, by means of which the results and insights from the deterministic and probabilistic assessments and any other requirements are combined in making decisions on safety matters in relation to the facility or activity.

SSR-2/2 Rev.1

4.32. If a probabilistic assessment of risk is to be used for decision making purposes, the operating organization shall ensure that the risk analysis is of appropriate quality and scope for decision making purposes. The risk analysis shall be performed by appropriately skilled analysts and shall be used in a manner that complements the deterministic approach to decision making, in compliance with applicable regulations and plant license conditions.

5.40. The design shall take due account of the failure of a passive component, unless it has been justified in the single failure analysis with a high level of confidence that a failure of that component is very unlikely and that its function would remain unaffected by the postulated initiating event.

8.6. A comprehensive and structured approach to identifying failure scenarios shall be taken to ensure the proper management of maintenance activities, using methods of probabilistic safety analysis as appropriate.

8.13. The operating organization shall ensure that maintenance work during power operation is carried out with adequate defense in depth. Probabilistic safety assessment shall be used, as appropriate, to demonstrate that the risks are not significantly increased.

SSG-3

3.3. After the objectives and the scope of the PSA have been specified, the management scheme for the PSA project should be developed, including the selection of methods and establishment of procedures, the selection of personnel and the organization of the team that will perform the PSA, the training of the team, the preparation of a PSA project schedule, the estimation and securing of the necessary funds, and the establishment of quality assurance procedures and peer review procedures.

3.7. The documentation for the PSA should be developed in a clear, traceable, systematic and transparent manner so that it can effectively support the review of PSA, applications of PSA and future PSA upgrades.

3.18. The final report of the PSA study should be divided into three major parts:

(1) Summary report;

(2) Main report;

(3) Appendices to the main report.

3.19. The summary report should be designed to provide an overview of the motivations, objectives, scope, assumptions, results and conclusions of the PSA at a level that is useful to a wide audience of reactor safety specialists and that is adequate for high level review. The summary report is designed:

(a) To support high level review of the PSA;

(b) To communicate key aspects of the study to a wide audience of interested parties;

(c) To provide a clear framework and guide for the reader or user prior to consulting the main report.

The summary report of a PSA should include a subsection on the structure of the report, which should present concise descriptions of the contents of the sections of the main report and of the individual appendices. The relation between various parts of the PSA should also be included in this subsection of the summary report.

3.20. The main report should give a clear and traceable presentation of the complete PSA study, including a description of the plant, the objectives of the study, the methods and data used, the initiating events considered, the plant modelling results and the conclusions. The main report, together with its appendices, should be designed:

(a) To support technical review of the PSA;

(b) To communicate key detailed information to interested users;

(c) To permit the efficient and varied application of the PSA models and results;

(d) To facilitate the updating of the models, data and results in order to support the continued safety management of the plant.

5.68. The documentation should also describe the plant damage states and should give a description of how they have been specified.

5.136. The Level 1 PSA documentation should present all the component failure data used in the quantification of the Level 1 PSA. The documentation should include a description of the component boundaries, the failure modes, the mean failure probability, the uncertainties associated with the data, the data sources used and the justification for the numerical values used.

10.18. The lists of cutsets should be used to determine whether there are any single order cutsets that will indicate that the single failure requirement is not complied with for any of the safety systems.

SUMMARY OF RECOMMENDATION AND SUGGESTIONS

AREA	RECOMMONDATIONS & SUGGESTIONS
LM	
TQ	
OPS	
MA	
TS	
OE	
RP	
CH	
EPR	
AM	
HTO	
LTO	
PSAA	

DEFINITIONS

DEFINITIONS – OSART MISSION

Recommendation

A recommendation is advice on what improvements in operational safety should be made in that activity or programme that has been evaluated. It is based on IAEA Safety Standards or proven, good international practices and addresses the root causes rather than the symptoms of the identified concern. It very often illustrates a proven method of striving for excellence, which reaches beyond minimum requirements. Recommendations are specific, realistic and designed to result in tangible improvements. Absence of recommendations can be interpreted as performance corresponding with proven international practices.

Suggestion

A suggestion is either an additional proposal in conjunction with a recommendation or may stand on its own following a discussion of the pertinent background. It may indirectly contribute to improvements in operational safety but is primarily intended to make a good performance more effective, to indicate useful expansions to existing programmes and to point out possible superior alternatives to ongoing work. In general, it is designed to stimulate the plant management and supporting staff to continue to consider ways and means for enhancing performance.

Note: if an item is not well based enough to meet the criteria of a '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 plant to…).

Good practice

A good practice is an outstanding and proven performance, 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 application to be brought to the attention of other nuclear power plants and be worthy of their consideration in the general drive for excellence. A good practice has the following characteristics:

- Novel;
- Has a proven benefit;
- Replicable (it can be used at other plants);
- Does not contradict an issue.

The attributes of a given 'good practice' (e.g. whether it is well implemented, or cost effective, or creative, or it has good results) should be explicitly stated in the description of the 'good practice'.

Note: 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 may be documented in the text of the report. 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 plant.

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

LIST OF IAEA REFERENCES (BASIS)

Safety Standards

- **SF-1**; Fundamental Safety Principles (Safety Fundamentals)
- **GSR Part 3;** Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, Interim Edition
- **SSR-2/1**; Safety of Nuclear Power Plants: Design (Specific Safety Requirements)
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- **GS-R-2**; Preparedness and Response for a Nuclear or Radiological Emergency (Safety Requirements)
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- **GSR** Part 4; Safety Assessment for Facilities and Activities (General Safety Requirements 2009)
- **GS-G-4.1**; Format and Content of the Safety Analysis report for Nuclear Power Plants (Safety Guide 2004)
- **SSG-2**; Deterministic Safety Analysis for Nuclear Power Plants (Specific Safety Guide 2009)
- **SSG-3**; Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants (Specific Safety Guide 2010)
- **SSG-4**; Development and Application of Level 2 Probabilistic Safety Assessment for Nuclear Power Plants (Specific Safety Guide 2010)
- **GS-R Part 5**; Predisposal Management of Radioactive Waste (General Safety Requirements)
- **GS-G-2.1**; Arrangement for Preparedness for a Nuclear or Radiological Emergency (Safety Guide)
- **GSG-2**; Criteria for Use in Preparedness and Response for a Nuclear and Radiological Emergency
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- **RS-G-1.8;** Environmental and Source Monitoring for Purpose of Radiation Protection (Safety Guide)

- **SSR-5;** Disposal of Radioactive Waste (Specific Safety Requirements)
- **GSG-1**; Classification of Radioactive Waste (Safety Guide 2009)
- **WS-G-6.1;** Storage of Radioactive Waste (Safety Guide)
- **WS-G-2.5;** Predisposal Management of Low and Intermediate Level Radioactive Waste (Safety Guide)

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Safety Report Series No.48; Development and Review of Plant Specific Emergency Operating Procedures

Safety Report Series No. 57; Safe Long Term Operation of Nuclear Power Plants

Other IAEA Publications

- **IAEA Safety Glossary** Terminology used in nuclear safety and radiation protection 2007 Edition
- **Services series No.12**; OSART Guidelines
- **EPR-EXERCISE-2005**; Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency, (Updating IAEA-TECDOC-953)
- **EPR-METHOD-2003**; Method for developing arrangements for response to a nuclear or radiological emergency, (Updating IAEA-TECDOC-953)
- **EPR-ENATOM-2002**; Emergency Notification and Assistance Technical Operations Manual

International Labour Office publications on industrial safety

- **ILO-OSH 2001;** Guidelines on occupational safety and health management systems (ILO guideline)
- Safety and health in construction (ILO code of practice)
- Safety in the use of chemicals at work (ILO code of practice)

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