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REPORT

OF THE

OPERATIONAL SAFETY REVIEW TEAM

(OSART)

MISSION

TO THE

SEQUOYAH

NUCLEAR POWER PLANT

UNITED STATES OF AMERICA

14 – 31 AUGUST 2017

DIVISION OF NUCLEAR INSTALLATION SAFETY
OPERATIONAL SAFETY REVIEW MISSION
IAEA-NSNI/OSART/195/2017

PREAMBLE

This report presents the results of the IAEA Operational Safety Review Team (OSART) review of Sequoyah Nuclear Power Plant, USA. It includes recommendations for improvements affecting operational safety for consideration by the responsible USA 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 USA organizations is solely their responsibility.

FOREWORD

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 at the Sequoyah Nuclear Power Plant in the USA from 14-31 August 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 twelve 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 Interactions; and Long Term Operations.

The mission was coordinated by an IAEA Team Leader and Deputy Team Leader and the team was composed of experts from Belgium, Brazil, Canada, France, Germany, Republic of Korea, Romania, Slovakia, Spain, Sweden, UK, and the IAEA staff members. The collective nuclear power experience of the team was approximately 409 years.

The team identified nineteen issues, resulting in six recommendations, and thirteen suggestions. Two good practices were also identified.

Several areas of good performance were noted:

- The plant has developed an overall Emergency Management Guideline flowchart to provide a comprehensive overview of all strategies, guidelines and other relevant documents.
- The plant has adopted an effective process to optimize the preventative maintenance programme.
- The plant has implemented a comprehensive seasonal preparation program.

The most significant issues identified were:

- The plant should place a higher priority on evaluating and improving the material condition of equipment commensurate with its safety significance.
- The plant should continue to improve the performance of management and staff in challenging inappropriate behaviours and coaching plant staff.
- The plant should improve the effectiveness of event investigation and corrective action implementation to minimize the risk of event recurrence.

Sequoyah 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 the USA, the IAEA conducted an Operational Safety Review Mission (OSART) at the Sequoyah Nuclear Power Plant between 14 and 31August 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; and Long Term Operations. 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 Sequoyah OSART mission was the 195th in the programme, which began in 1982. The team was composed of experts from Belgium, Brazil, Canada, France, Germany, Republic of Korea, Romania, Slovakia, Spain, Sweden, UK, and the IAEA staff members. The collective nuclear power experience of the team was approximately 409 years.

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

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

The following report summarizes the findings of the review team 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 Sequoyah NPP are committed to improving the operational safety and reliability of their plant. The team found several good areas of performance, including the following:

- The plant has developed an overall Emergency Management Guideline flowchart to provide a comprehensive overview of all strategies, guidelines and other relevant documents.
- The plant has adopted an effective process to optimize the preventative maintenance programme.
- The plant has implemented a comprehensive seasonal preparation program.

Several proposals for improvements in operational safety were offered by the team. The most significant of these are the following:

- The plant should place a higher priority on evaluating and improving the material condition of equipment commensurate with its safety significance.
- The plant should continue to improve the performance of management and staff in challenging inappropriate behaviours and coaching plant staff.
- The plant should improve the effectiveness of event investigation and corrective action implementation to minimize the risk of event recurrence.

Sequoyah 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

The plant has a comprehensive plan to improve and sustain performance. The plant has four focus areas: alignment; leadership effectiveness; operational focus and equipment reliability. However, the team noted that the plant management and staff do not always challenge inappropriate behaviours or provide coaching to ensure that expectations on safety of activities conducted in the field are met. During observations, deficiencies in material condition, work practices, workplace safety and housekeeping were found. The team concluded that the plant should continue to focus on improving challenging inappropriate behaviours and coaching and made a recommendation in this area.

The plant utilizes an electronic polling tool once a week to determine the effectiveness of vertical alignment with the workforce. The strategic questions target each individual contributor to verify that short term goals, corrective actions and focus areas have been effectively communicated from senior leaders, through the management chain and ultimately to the worker. The results of the polling are critiqued during the weekly Leadership Forum where first line supervisors and managers interactively discuss weekly site performance results. The team recognized this as a good performance.

1.2. INTEGRATED MANAGEMENT SYSTEM

The Nuclear Operating Model (NOM) issued by the corporate organization describes mission, vision and overarching principles and policies. The NOM describes how responsibilities are assigned in the organization and also describes execution and governance of nuclear activities. The corporate safety policy is general and valid for all activities but it is not widely known and does not put focus on nuclear safety. The team encouraged the plant to improve the safety policy document to provide specific guidance for all nuclear activities.

The plant has several means of reviewing and assessing safety, including review committees, corporate functions and external reviewers. However, the plant process for Operational Decision Making Issue (ODMI) evaluation has no general requirement for independent challenge and no requirement to assign someone to challenge the decision making from a conservative decision-making perspective. The team encouraged the plant to use independent challenge as part of the process in all decision making processes important to nuclear safety.

1.3. NON-RADIATION-RELATED SAFETY PROGRAMME

The plant indicators show an improving trend with respect to industrial safety accidents. However, industrial safety requirements were not always followed and the team identified several industrial safety hazards in the field. The team made a suggestion in this area.

DETAILED LEADERSHIP AND MANAGEMENT FOR SAFETY

1.1 LEADERSHIP FOR SAFETY

1.1(1) Issue: The plant management and staff do not always challenge inappropriate behaviours or provide coaching to ensure that expectations on safety of activities conducted in the field are met.

The team noted the following:

– A worker on the spent fuel pool bridge inclined half of his body out of the bridge, over the pool, without wearing a safety harness, to release the fuel handling tool from the bottom of the bridge.
– In the emergency diesel generator building, a worker was sitting on an Essential Raw Cooling Water (ERCW) pipe in the corridor and with the working document binder on a nearby valve. He was not challenged or coached.
– Three workers sat on the hypochlorite pipes (four one inch pipes in parallel) in front of the ERCW building.
– While flushing a sample line from the Refuelling Water Storage Tank (RWST), a technician’s hand was in contact with process water which is potentially radioactive. The technician did not change gloves or wash them prior to taking actual water sample.
– While flushing the sample line from RWST, a technician remained in front of the panel instead of stepping back to reduce dose rate and did not check ventilation flow prior to the sample collection.
– In the diesel generator building, a worker walked down stairs with equipment in both hands and could not use the hand rail.
– In June 2017, a supervisor decided to proceed with a task despite knowing that there was a safety concern and he fell off a ladder and was injured.
– During proficiency training, two trainees touched components on a simulated plant instrument rack equipment multiple times while performing an inspection activity. One trainee stepped up onto the instrument rack, using it as a ladder. A trainee also moved a heavy piece of equipment across the floor while crouched over. No coaching on these behaviours was provided by the instructor.
– In many plant areas good housekeeping conditions were not maintained. The housekeeping in the Shift Manager Conference room in the plant was poor with cardboard boxes and equipment stored throughout the room.

Without consistently challenging inappropriate behaviour and coaching promptly, the safety of plant activities could be compromised.

Recommendation: The plant should continue to improve the performance of management and staff in challenging inappropriate behaviours and coaching plant staff.

IAEA Bases:
GSR Part 2

3.1. The senior management of the organization shall demonstrate leadership for safety by:
(c) Establishing behavioural expectations and fostering a strong safety culture.

3.3. Managers at all levels in the organization:

(a) Shall encourage and support all individuals in achieving safety goals and performing their tasks safely.

SSR-2/2

4.35. Monitoring of safety performance shall include the monitoring of: personnel performance; attitudes to safety; response to infringements of safety; and violations of operational limits and conditions, operating procedures, regulations and licence conditions. The monitoring of plant conditions, activities and attitudes of personnel shall be supported by systematic walkdowns of the plant by the plant managers.

GS-G-3.1

2.11. The management system should assign responsibility to achieve the organization's objectives and should empower the individuals in the organization to perform their assigned tasks. Managers should be responsible for achieving quality and safety in the final outputs of work under their responsibility within the organization. Individuals should take responsibility for quality and safety while carrying out the work that is assigned to them. In order to discharge this responsibility, individuals should be technically competent in using the appropriate hardware, equipment, tools and measuring devices and should have a clear understanding of the work processes.

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.

GS-G-3.5

2.15. Senior managers should be the leading advocates of safety and should demonstrate in both words and actions their commitment to safety. The 'message' on safety should be communicated frequently and consistently. Leaders develop and influence cultures by their actions (and inactions) and by the values and assumptions that they communicate. A leader is a person who has an influence on the thoughts, attitudes and behaviour of others. Leaders cannot completely control safety culture, but they may influence it. Managers and leaders throughout an organization should set an example for safety, for example, through their direct involvement in training and in oversight in the field of important activities. Individuals in an organization generally seem to emulate the behaviours and values that their leaders personally demonstrate.

1.3 NON-RADIATION-RELATED SAFETY PROGRAM

1.3(1) Issue: The plant processes for industrial safety are not always effective in identifying and mitigating industrial safety hazards to personnel.

The team noted the following:

– In the Unit 1 turbine building, two uninsulated pipes were protruding from the high pressure turbine casing, causing a risk of personnel injury.
– In the Unit 1 turbine building, six studs were found protruding 2 to 3 cm from the floor at ground level, unprotected and unmarked, creating a tripping hazard.
– In the auxiliary building battery room, a cable and metal plate were found hanging, potentially causing an electric hazard.
– A hot pipe was uninsulated in Unit 1 turbine building.
– Hoses were lying on the floor in Unit 2 turbine building without barriers or hazard signs.
– Two Unit 1 Condenser Circulating Water cooling tower lift pumps had significant gland leakage and leak catching trays were overflowing. The water had spread over the pump access walkway, causing a significant slip hazard, particularly for operators at night.
– A worker was not wearing safety glasses inside the clean machine shop.

Without actively identifying and reducing industrial safety hazards, the potential for personnel injury will increase.

Suggestion: The plant should consider improving the industrial safety program to reduce the industrial safety hazards to plant personnel.

IAEA Bases:

SSR-2/2

5.26: The non-radiation-related safety program shall include arrangements for the planning, implementation, monitoring and review of the relevant preventive and protective measures, and it shall be integrated with the nuclear and radiation safety program. All personnel, suppliers, contractors and visitors (where appropriate) shall be trained and shall possess the necessary knowledge of the non-radiation-related safety programme and its interface with the nuclear and radiation safety programme, and shall comply with its safety rules and practices. The operating organization shall provide support, guidance and assistance for plant personnel in the area of non-radiation-related hazards.

GS-S-3.1

2.34. Senior management should have an understanding of the key characteristics and attributes that support a strong safety culture and should provide the means to ensure that this understanding is shared by all individuals. Senior management should provide guiding principles and should reinforce behavioural patterns that promote the continual development of a strong safety culture.

2.36. A strong safety culture has the following important attributes:

− Safety is integrated into all activities:

- Consideration of all types of safety, including industrial safety and environmental safety, and of security is evident.
- Housekeeping and material conditions reflect commitment to excellence.

2. TRAINING AND QUALIFICATIONS

2.1. ORGANIZATION AND FUNCTIONS

The team noted that training facilities, including classrooms, training laboratories and a full scope simulator, do not always fully replicate the conditions and standards expected in the plant and that the instructors do not always promote and model the standards expected in the plant. The training environment was not always a realistic replication of the environment expected in the plant and as a result, did not always promote positive carry-over from the training environment to the actual workplace. Some expectations in the training environment below plant standards could condition workers to accept low standards in the plant. The team made a suggestion in this area.

The corrective action plan for the low Initial License Training (ILT) throughput for reactor operators has not been implemented as originally scheduled with several actions extended multiple times. The corrective actions on their own are not sufficient to address the adverse condition and there is reliance on other improvement initiatives to ensure that the condition is addressed. The team encouraged the plant to continue improvements in selection, training, mentoring and oversight to increase throughput of the ILT program in an effective and sustainable manner.

2.2. QUALIFICATION AND TRAINING OF PERSONNEL

High Intensity Training (HIT) simulator exercises are attended by operations management who engage with the simulator instructors during the training scenarios via headset communication to discuss performance, intervention and use of stop and back-track training tools to improve crew performance. Operations management and training instructors took opportunities to freeze the simulator and engage the crew in discussions about standards and expectations related to crew performance several times during the simulator exercises. In several cases the crew repeated a portion of the event to perform to a higher standard after completion of the discussion during the freeze. The team recognized this teamwork between operations management and training as a good performance.

DETAILED TRAINING AND QUALIFICATION FINDINGS

2.1. ORGANIZATION AND FUNCTIONS

2.1(1) Issue: Standards in the training environment do not always match those expected in the plant.

The team noted the following:

- There were signage and labelling deficiencies in the training areas:
  - There was no Personal Protective Equipment (PPE) signage or floor markings on where PPE requirements change in the electrical maintenance shops in the training facility.
  - There was a chain across the Radiation Protection (RP) laboratory doorway in the training facility with a paper sign taped to it.
  - Equipment identification labels in the training equipment for maintenance of a diesel generator and a Terry Turbine, as well as the flow loop simulator, did not match the format used in the plant.
  - Protected equipment signage on simulator hand-switches was applied differently than the plant expectations.
- A simulator instructor was observed to interact directly with crew members during a performance mode simulator training exercise. This occurred several times with different crew members. Interactions also occurred between simulator instructors and crew members during a training mode simulator exercise while the simulator was running and the crew was actively performing training. This does not meet training management's expectations.
- During a discussion on expectations and requirements related to a specific human performance tool in a High Intensity Training (HIT) simulator scenario, the simulator instructors were not clear on the performance expectations associated with that specific human performance tool and were unable to find the procedural requirements in a timely manner.
- In several simulator scenarios the crew attempted to use trend information that would have been available to them in the plant but could not access the information on the simulator.
- An individual undergoing simulator training used a heavy duty stapler as a hammer on a folder provided during turnover. About eight other individuals were present and did not intervene or provide coaching afterwards.
- There were housekeeping deficiencies in the training areas:
  - A cover panel on the simulator was removed to provide enhanced cooling due to elevated temperatures in the panel. This was not identified in accordance with plant expectations.
  - There were several items stored behind the simulator panels that were visible to the operating area of the simulator.
  - In several training laboratories there were boxes and other equipment stored on top of the workbenches and cabinets instead of inside the cabinets.
  - There was a wooden storage pallet with caution tape frayed around the edges and a box containing a battery that appeared to have been in place for an extended time at a doorway to the electrical maintenance shop in the training facility.

- There was a newspaper clipping posted beside a safety poster at the front of a classroom.
- Housekeeping in the operator Initial License Training (ILT) room was poor with boxes of binders and papers as well of stacks of drawings on the floor in many areas.
- The housekeeping in a training facility mechanical equipment room that was being used for training was poor with cardboard boxes stored throughout the room including boxes that were resting against air conditioning unit piping.

Expectations in the training environment that are below plant standards could condition workers to accept low standards in the plant.

Suggestion: The plant should consider improving the standards in the training environment to match those expected in the plant.

IAEA Bases:

SSR-2/2

4.17. Suitably qualified personnel shall be selected and shall be given the necessary training and instruction to enable them to perform their duties correctly for different operational states of the plant and in accident conditions, in accordance with the appropriate procedures.

4.21. The training programmes shall be assessed and improved by means of periodic review. In addition, a system shall be put in place for the timely modification and updating of the training facilities, computer models, simulators and materials to ensure that they adequately reflect current plant conditions and operating policy, and that any differences are justified.

4.23. All training positions shall be held by adequately qualified and experienced persons, who provide the requisite technical knowledge and skills and have credibility with the trainees. Instructors shall be technically competent in their assigned areas of responsibility, shall have the necessary instructional skills, and shall also be familiar with routines and work practices at the workplace. Qualification requirements shall be established for the training instructors.

4.24. Adequate training facilities, including a representative simulator, appropriate training materials, and facilities for technical training and maintenance training, shall be made available for the training of operating personnel. Simulator training shall incorporate training for plant operational states and for accident conditions.

NS-G-2.8

4.5. The training needs for duties important to safety should be considered a priority, and relevant plant procedures, references, resources, tools, equipment and standards should be used in the training process to ensure, as far as practicable, that errors, omissions and poor practices are not accepted. For these critical duties, the training environment should be as realistic as possible, to promote positive carry-over from the training environment to the actual job environment.

4.18. The training of control room operators should include, as a minimum, classroom training, on the job training and simulator training. The classroom training and on the job training should be planned and controlled to ensure that all necessary objectives are achieved during the training period. Simulator sessions should be structured and planned in detail to ensure adequate coverage of the training objectives and to avoid possible negative training due to the limits of simulation. The sessions should include preliminary briefings and follow-up critiques.

3. OPERATIONS

3.1 ORGANIZATION AND FUNCTIONS

The team noted that current numbers of trained and licensed personnel in the Main Control Room (MCR) shift teams are challenging and are clearly, on occasions, a distraction from core operational activities. Of particular note is the insufficient number of Reactor Operators (RO). The present number of staff available for shift cover is nineteen instead of the minimum of twenty. This has periodically required the use of Senior Reactor Operators (SROs) and Shift Managers to cover RO and SRO positions. On two occasions alternative methods of covering shifts have required less than ideal arrangements to maintain the minimum personnel requirements. Additional ROs are in training but are not likely to be available until January 2018. The plant is encouraged to consider ways to develop a more robust staffing strategy that includes some contingency for anticipated retirements and natural attrition.

During the course of observations in the MCR the team noted that, at present, the management and control of MCR Operators rest periods, away from the control panels during the course of a 12 hour shift, is not clearly defined in operations department control procedures. To optimize alertness and responsiveness the plant is encouraged to define a minimum period of time that the operators should ideally spend away from the controls during the course of a single 12 hour shift, on the understanding that they remain fully available if required back at the controls at any time. These breaks would always be taken when operationally convenient.

3.2. OPERATIONS FACILITIES AND OPERATOR AIDS

The plant has established several processes that support continued safe reliable operations.

The use of plant specific chronological logs that span several days is a useful communication tool. An example is the ability to carry forward all log entries for the whole Diesel Generator overhaul period. The team recognized this as a good performance.

The interaction between the Clearance Software Program and the Surveillance Instructions enhances the plant arrangements for configuration control. This capability allows, during the release and operation of a plant item, the Independent Verification to be recorded and subsequently reviewed electronically using established Surveillance Instructions. The team recognized this as a good performance.

The plant has provided some plant based operational tools to assist with essential operations in an emergency. The arrangements consist of luminous tags that provide enhanced visibility of specific plant items that might need to be operated during loss of normal lighting. The arrangements apply to Emergency Operating Instruction (EOI), the Extended Loss of AC Power and FLEX Procedures and provide a higher level of confidence that operators in the field can easily locate key items under adverse conditions. The team recognized this as a good performance.

3.3 OPERATING RULES AND PROCEDURES

The plant has a procedure for Critical Safety Function (CSF) assessment during shutdown. However, some decision making criteria and acceptance criteria are not clearly stated. The plant has developed proper contingency plans during shutdown; however these are not linked or included in the CSF assessment procedure. The team encouraged the plant to review and improve the procedure.

3.4 CONDUCT OF OPERATIONS

During the course of a number of plant walk downs the team noted a range of inconsistencies in the standard of plant equipment identification and labelling. There is a range of labels that do not clearly describe the plant equipment. In a small number of instances there were labels missing. The inconsistencies could lead to incorrect identification of some equipment which could be a precursor to a configuration control event or a clearance process event. The team made a suggestion in this area.

The plant has a risk mitigation process in the form of the provision of physical equipment protection. The team noted that this process was not being applied consistently or in accordance with the procedure. The circumstances where the protection should be deployed are being interpreted in different ways and the intent for shorter duration jobs does not align with the plant procedure. Additionally, the protection measures on the plant are not applied to the same standard in all areas. The team made a suggestion in this area.

The team observed that plant deficiencies on structures, systems and components in the field were not always recorded and identified deficiencies were not readily apparent in the field. Different kinds of leaks, instruments with wrong values displayed and areas with missing insulation were found, each without an open Work Order (WO) in the system. The team made a suggestion in this area.

3.5. WORK CONTROL

The Operations shift team structure includes two members of staff who interface with the rest of the organization. One SRO is based in the Work Control Centre (WCC), and provides a point of contact for work start permission and all other enquiries that can be managed away from the control room. The second SRO (Floor) attends meetings related to shift crew activities, oversees field operations, makes observations in the field and deals with Assistant Unit Operators' (AUO) tasks. The structure also includes additional day-based staff for work control support and Work Management interaction. An Online and Outage Tagging Office has also been implemented. These arrangements ensure that concurrent and independent verification of clearance activities in the field can be carried out effectively and minimize MCR distractions. The team recognized this as a good performance.

DETAILED OPERATIONS FINDINGS

3.4 CONDUCT OF OPERATIONS

3.4(1) Issue: Plant identification and labelling is inconsistent in its format and content.

The team noted the following:

- There were many different designs of plants labels fitted to valves. Some were not clear.
- Some valve labels were noted where only the unique identifier was displayed and no narrative detail. In other cases, the narrative detail was significantly abbreviated and the meaning open to interpretation.
- Some equipment was noted to have labels missing, i.e., Essential Raw Cooling Water (ERCW) pumps QA and RA have no identification on their discharge pressure switch isolating valves.
- Cooling tower lift pump gate hoists were only labelled in some instances. Those near the tower did have identification, others did not.
- There were both orange and brown labels evident on the same ERCW pump. The colour should identify which plant train the pump is associated with.

Lack of consistency in plant equipment identification could lead to incorrect interpretation and errors in plant manipulations.

Suggestion: The plant should consider improving the format and content of plant equipment labeling.

IAEA Bases:

NS-G 2.14

5.1. A consistent labelling system for the plant should be established, implemented and continuously maintained throughout the lifetime of the plant. It should be ensured that the system is well known by the staff.

The system should permit the unambiguous identification of every individual component in the plant. In addition to the labelling of plant components, labelling of the doors and compartments of the plant should be regarded as part of the same system.

5.2. The labelling standards used should be such as to ensure that the labels are suitable for the environmental conditions in the location in which they are to be mounted and that the equipment can be unambiguously identified. The format and placement of labels should allow the operators to identify the component quickly and easily and should prevent the easy or inadvertent removal or misplacement of labels.

5.3. The plant management should ensure that all valves, switches, breakers and components are labelled using the same labelling nomenclature as that prescribed in current design documents. Furthermore, operations procedures and documents should also reflect the same nomenclature. When discrepancies are found, they should be reported and corrected in accordance with the established procedure. To assist in the management of the labelling programme, the number of discrepancies awaiting correction should be tracked and monitored.

3.4(2) Issue: The protection of in-service and available safety-related equipment is not consistently applied in accordance with the plant procedures.

The team noted the following:

- Two ERCW pumps were logged as protected. However, only one of the two pumps had Protected Plant barrier tape around it and it had a scaffold erected in the protected area.
- The 2A Containment Spray Pump was taken out of service and isolated for minor maintenance. The pump was released overnight and was planned for return by 17:00. No plant protection was applied to the remaining pump as required by the procedure.
- The 1A Diesel Generator was released for maintenance and the Limiting Condition for Operation (LCO) entered at 02:09 in the morning. The diesel work was completed and declared available at 16:30. No plant protection was applied for the duration of this work as required by the procedure.
- A Work Control Centre, Senior Reactor Operator (SRO) stated that he did not understand why the plant protected so much equipment.
- A previous self-assessment by the Quality Assurance Department identified shortfalls in the protected plant process in 2015. These have not all been addressed.

Without carrying out appropriate plant protection measures the availability of safety-related equipment could be challenged.

Suggestion: The plant should consider clarifying and improving the process and application for protected equipment identification signs and barriers.

IAEA Bases:

NS-G 2.14

5.12. Before equipment is released from service, consideration should be given to testing the redundant trains or single components that remain in service. The need for additional testing to verify availability should be evaluated on the basis of the number of redundancies, the importance to safety of each redundant train or component and the interval since the last test. Operations personnel should evaluate the results of such tests before commencing the process of tagging. Before initiating the tagging process for trains or components, the shift supervisor should conduct a pre-job briefing, which should also cover the status of the plant and non-related components or trains. Additionally, procedures should be established to provide for warning barriers and signs located in the plant close to such redundant systems to alert operators and workers to their special protected status.

3.4(3) Issue: Plant deficiencies in the field were not always recorded, and the identified deficiencies were not readily apparent in the field.

The team noted the following:

- The plant did not provide visible identification for the deficiencies recorded on structure, system and components (SSC) in the field.
- Main Steam valve 2-1-920 and its series valve were leaking. There was no WO open.
- 1A Feedwater Pump (MFPT-1A) had a puddle of water on the base plate. There was no Work Order (WO) open.
- Raw Cooling Water Pumps (0-PMP-24-7 and 0-PMP-24-10) seal leakage into the drain catchment was overflowing, causing puddles of water on the floor and on the pump bedplate. There was no WO open.
- A Recirculation Pump (2-PMP-27-760) had a water leak. There was no WO open.
- Two Main Steam valves (2-1-722 and 723) were leaking. There was no WO open.
- Heater C6 Inlet Pressure Indicator (2-PI-6-176) displayed the wrong value. There was no WO open.
- Condenser A CCW West Side Inlet Pressure Indicator (2-PI-27-92) displayed the wrong value. There was no WO open.
- Steam Generator Blow Down first stage flow switch (2-PDIS-2-329) displayed the wrong value. There was no WO open.
- Gland Cooling Flow Orifice (0-OR-24-642) had a spray leakage from a screwed connection. The leak was reported in the Condition Report System on 4 April 2017 and a WO (118643080) was issued on 19 Apr. 2017. This was cancelled and a new WO (114240649) was issued. On 17 July 2017, the new WO was also cancelled and a new WO (114361361) was issued again. This WO was closed on 24 July 2017. There was currently no WO open.
- Strainer to Space Cooler 2B (2-STN-24-202) had a water leak. There was no WO open.
- Leak on Injection Water valve (1-54-501) did not have an open WO.
- Leak on Condenser Circulating Water collector (1-27-734) did not have an open WO.
- Insulation between 1-MTRB-6-220 and 1-MTRB-6-217 valves was missing. There was no WO open.
- Insulation on 1-6-776 valve was missing. There was no WO open.
- There was no insulation on the discharge pipe of Heater Drain Pump 2A (2-PMP-6-12). There was no WO open.

Without identifying and recording deficiencies in the field in a timely manner, the degradation of plant structures, systems and components may not be rectified resulting in a challenge to plant availability and reliability.

Suggestion: The plant should consider improving the recording of deficiencies and making the record readily apparent in the field.

IAEA Bases:

SSR-2/2

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

NS-G-2.14

5.50. Deficiencies in equipment should be clearly identified to make them readily apparent to the operations personnel who conduct plant rounds and make observations. A system of tagging for deficiencies and/or cautions should be implemented to mark problems with equipment. Deficiencies that are identified should be assessed for their safety significance and should be prioritized for their correction.

4. MAINTENANCE

4.3. MAINTENANCE PROGRAMMES

The plant uses an asset database system to control and track assets, materials, condition reports, and work orders. One of the system's functions is a Preventive Maintenance (PM) feedback function titled PM 360 feedback. The asset database system allows an originator to provide feedback on work orders. After the feedback is resolved, the system automatically sends an e-mail to the feedback originator, letting them know that the feedback has been resolved and contains links to allow them to see the resolution. This feedback system allows technicians to provide a numerical grading to the work, which is then used to determine if the work scope and frequency is adequate or needs to be changed. By adopting this feedback system, about 100 PM frequency and scope of work changes were made based on the technicians' feedback during a recent PM review. The team recognized this as a good practice.

4.5. CONDUCT OF MAINTENANCE WORK

The team observed that some maintenance activities are not controlled and performed effectively to ensure safe and reliable performance of systems and equipment. Worksites are not always properly prepared and controlled and work areas are not always well organized. For example, lay down areas were not assigned for tools and disassembled parts. Several Foreign Material Exclusion (FME) control weaknesses were identified such as inadequate housekeeping around the spent fuel pool platform and missing FME caps during some maintenance work activities. The team made a suggestion in this area.

4.6. MATERIAL CONDITION

The team noted that material condition of some plant equipment and structures is not consistently maintained to ensure equipment reliability and safety. The team identified heavily corroded equipment, water leakage, oil leakage, and insulation damage in several areas. Plant personnel had not proactively intervened to solve these problems in a timely manner. The plant should place a higher priority on evaluating and improving the material condition of equipment commensurate with its safety significance. The team made a recommendation in this area.

4.7. WORK CONTROL

The plant has adopted a Responsible Task Lead (RTL) program to better control on-line work management for work activities which need more focus. The RTL position greatly enhances the communication and coordination efforts of all the work groups involved in a complex or risk sensitive task. The RTL is focused on ensuring continuous work and error-free handoffs between work groups. The RTL is fully engaged in the oversight of the work and proactive in identifying and resolving any potential problems. The team recognized this as a good performance.

DETAILED MAINTENANCE FINDINGS

4.3. MAINTENANCE PROGRAMMES

4.3.(a) Good Practice: Use of Preventive Maintenance (PM) 360 Feedback System
The plant uses an asset database system to control and track assets, materials, condition reports, and work orders. This database system contains a function known as PM 360 feedback. PM 360 feedback is a system function that automatically sends update emails to the originator of the Condition Report (CR) or Work Order (WO) feedback. This enables the originator to know when their concern or input has been addressed.

- On the CR side of the database system, an e-mail is sent informing the originator when the CR has been closed, allowing the originator to review the actions taken to address their concern.
- On the WO side of the database system, several different things occur when the originator provides feedback on the WO or PM.
  - Several additional fields open up to allow the originator the option to input whether or not the PM is still valid and needed; the frequency correct; and to input a number rating for the condition of the equipment. This feedback system also allows the technicians to provide a numerical grading system to the work, which is then used to determine if the work scope and frequency is adequate or needs to be changed. Additionally, there is a narrative field to add comments.
  - When the feedback issue is closed, an e-mail is sent to the originator informing them that their feedback has been addressed. The originator is then able to review the actions taken to determine if they have met their concern.

By adopting this feedback system, around 7000 feedback requests were received, resulting in 190 items being updated during the previous two years. During a recent PM review, about 100 PM frequency and scope of work changes were made based on the technicians' feedback.

4.5. CONDUCT OF MAINTENANCE WORK

4.5(1) Issue: Some maintenance activities are not controlled and performed effectively to ensure safe and reliable performance of systems and equipment.

The team noted the following:

- Maintenance Practice
  - While disassembling the Condenser Cooling Water (CCW) system Screen Wash pump 1 C Discharge Strainer, a worker hung the disassembled strainer basket on the two studs of the bonnet flange.
  - During CCW Screen Wash pump strainer work, workers did not thoroughly inspect the bonnet gasket. The gasket contact faces between the bonnet and the cover flange of the strainer were not cleaned, and the stud threads were not cleaned before reinstallation. The procedure did not describe ‘inspect gasket and replace bonnet gasket as required’ in detail, and did not mention cleaning the gasket contact faces between the bonnet and the cover flange, or the stud threads.
  - During Essential Raw Cooling Water (ERCW) system Strainer A1A-A motor bearing replacement work, the rigging bars were not installed in the right position just above the motor. The work was delayed to reposition the rigging bars.
  - During Centrifugal Charging Pump 2A-A Motor oil replacement work, a worker used an adjustable wrench to open the oil drain plug. Rounded edges of the drain plug head were identified by team. The plant allowed the use of adjustable wrenches as described in a procedure which describes the instructions on how to use adjustable wrenches.
  - During Diesel Generator (DG) 1A starting compressor 1A-2 PM work, workers put nuts and tools (spanners and box wrenches) on the bed of the compressor. No lay down area was designated.
  - During penetration room cooler 2A-A (2-CLR-30-186-A) cooling coil replacement, there was no lay down area for tools and disassembled parts; and no work area fence was installed. Workers put two disassembled elbows, tools, and procedures on the top of the new cooler package. Another worker put the disassembled bolts and nuts, electric cutting saw, and procedure on the top of a drum (for essential raw cooling water drain collection) located at the work area.
  - Inadequate housekeeping was identified including tools around ERCW Pump M-B (0-PMP-67-444-B) with the motor removed.
  - A documented list of tools and consumables did not exist in the work package for ERCW system Strainer A1A-A motor bearing replacement work, as a result workers prepared many tools and consumables based on their own memory.

- Weaknesses in housekeeping and FME
  - A Control Rod Drive Mechanism (CRDM) air conditioning unit under maintenance had the control access panel open. Two openings had no FME caps installed.
  - A FME cover was not installed on the pipe detached from ERCW M-B motor for maintenance.
  - There were 2 hard metallic wire wheel brushes on the ground in Auxiliary Building EL 734, which is 0.5 m from the border of a level 1 FME zone.
  - On the Spent Fuel Pool (SFP) platform, numerous scraps of plastic tie wraps were on the ground, among these, there were two 3cm-long hard wire scraps on the ground, and inadequate general housekeeping in that area.

  - Steel wire pieces (3-20 cm in length) were found in multiple areas throughout the auxiliary and ERCW buildings.
  - 10cm-long nail was found on the ground behind electrical cabinet 2A-RCP3 in the Auxiliary Building.
  - Metallic scraps were found below charging pump 1A-A in the Auxiliary Building.
  - Several pieces of transparent plastic were found in multiple locations within the auxiliary building.

- Previous events related to poor workmanship or rework:
  - In January 2017, the 1A-A DG was stopped due to an oil leak. The oil leak was found when Mechanical Maintenance Group (MMG) removed an inspection cover during the first over speed test run. It was noted that a gasket was not properly aligned.
  - In June 2016, Auxiliary Charging Pump 1B (1-PMP-84-21) was leaking oil onto the floor and creating a slip hazard. This was previously worked on in March 2016.
  - In January 2017, while performing maintenance on the 1A-A DG, the injector jumper lines were not properly seated during re-installation.
  - In Unit 1 Refuelling Outage 21, multiple components had to be reworked, some delayed critical path due to lack of ownership of the components being worked on.

Without the proper control and implementation of maintenance activities, the maintenance work quality could be challenged which could adversely effect availability and reliability of plant equipment and systems.

Suggestion: The plant should consider improving the control and implementation of maintenance activities to ensure safe and reliable performance of systems and equipment.

IAEA Bases:

SSR-2/2

7.11. An exclusion programme for foreign objects shall be implemented and monitored, and suitable arrangements shall be made for locking, tagging or otherwise securing isolation points for systems or components to ensure safety.

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.

8.8. A comprehensive work planning and control system shall be implemented to ensure that work for purposes of maintenance, testing, surveillance and inspection is properly authorized, is carried out safely and is documented in accordance with established procedures.

8.9. An adequate work control system shall be established for the protection and safety of personnel and for the protection of equipment during maintenance, testing, surveillance and inspection. Pertinent information shall be transferred at shift turnovers and at pre-job and post-job briefings on maintenance, testing, surveillance and inspection.

NS-G-2.5

5.19. A policy for the exclusion of foreign materials should be adopted for all storage of irradiated fuel. Procedures should be in place to control the use of certain materials such as transparent sheets, which cannot be seen in water, and loose parts.

GS-G-3.1

2.21. All work that is to be done should be planned and authorized before it is commenced. Work should be accomplished under suitably controlled conditions by technically competent individuals using technical standards, instructions, procedures or other appropriate documents.

NS-G-2.14

4.27. Pre-job briefings should be used as a means of avoiding personnel errors, difficulties in communication and misunderstandings.

NS-G-2.6

5.2. The operating organization should require the plant management to prepare procedures that provide the detailed instructions and controls necessary for carrying out MS&I activities.

5.14. A comprehensive work planning and control system applying the defence in-depth principle should be implemented so that work activities can be properly authorized, scheduled and carried out by either plant personnel or contractors, in accordance with appropriate procedures, and can be completed in a timely manner. The work planning system should maintain high availability and reliability of important plant SSCs.

4.6. MATERIAL CONDITION

4.6(1) Issue: The material condition of some plant equipment and structures is not consistently maintained to ensure equipment reliability and safety.

The team noted the following:

- Corrosion and rusting:
  - Auxiliary Building Water Chiller A-A Cooling Water System shut off valve (0-310-980) and next elbow (30cm) heavily corroded.
  - Shutdown Board Room Chiller A&B cooling water system Circulating Pump B-B suction line valve and related piping heavily corroded.
  - Raw cooling water booster pump B bed plate and pump casing bolts in auxiliary building EL 173 was heavily corroded.
  - ERCW strainer (B2B-B) flange and bolts were heavily corroded.
  - ERCW strainer hypochlorite isolation valve downstream of 2A Valve (2-VLV-50-520) was corroded.
  - ERCW strainer B1B-B has rusted bolting in multiple locations.
  - ERCW strainer A1A-A has rusted bolting in multiple locations.
  - Poor material condition of chiller system in auxiliary building top floor in Unit 1.
  - Rusty bolts in electrical board room condensers on lowest floor of chiller building (EL 662 of control building) in Unit 1 and 2 Turbine Building.

- Water leakage:
  - Water was leaking from a plug in the lower part of the pump stand resulting in a puddle around ERCW Pump K-A.
  - Containment Spray Pump (SCP) 2A-A outboard Mechanical seal leakage (1 drop per 2 minutes) and crystalized boron deposit present.
  - Water leak under Main Feed water Pump B (about 70cm x 70cm) in Unit 1.
  - In Unit 2 Turbine Building EL 685, a steam leak and puddle extended 14m x 2m. Staining on the floor indicated this leak had been present for an extended period.
  - Water leakage at Moisture Separator Reheater (MSR) 2A1 in Unit 2.
  - Water leak on floor extended 2m x 1m with extensive staining indicating leak has been present for an extended period in Unit 2 Turbine Building EL 685 (K-T10).
  - Water leak (1drop per 3 sec) at First Stage blowdown heat exchanger outlet local sample valve in Unit 2.

- Oil leakage:
  - In the Diesel Generator (DG) 1A room, an oil puddle (30cm x 30cm) was found below the engine coupling between 1A-1 and 1A-2 engines, and an oil puddle was present on the floor at the rear side of engine.
  - In DG 1A room, several oil leaks were identified: 1A-2 engine soak back pump (20cm x 20cm oil puddle); oil puddle under lubricating oil filter in 1A-2 engine; engine drain valve (0-VLV-82-773) in 1A-2; turbo charger 1A-2; oil leakage at several spots under lubricating oil filter (1-FLT-82-0820/1A) of engine 1A.
  - In DG 2A room, 2A-2 soak back pump oil leak, 2A-1 right rear #8 engine inspection cover oil leak (20cm x 100cm), several spots of oil leakage were present under the lubricating oil filter of engine 2A-1.

  - Oil leakage (about 20cm x 20cm) was found under the Feed Pump Lube Oil Condenser Heater in Unit 1.

- Insulation damage:
  - Several areas of insulation were missing: DG 1A-1 ERCW supply train A line (30cm) where marking for in-service inspection existed on the bare pipe, DG 1A-2 ERCW supply valve elbow (40cm) with in-service mark, DG 2A-2 ERCW supply line (1m).
  - Foam insulation was detached on the spot above the bed plate of ERCW strainer B2B-B
  - Foam insulation was split on the backwash line of ERCW strainer B2B-B.
  - A heat trace component at 2-REH-001-0135 enclosure had exposed wiring and was not sealed. This box is outside and could be exposed to rain.
  - Degraded insulation and incomplete coverage of insulation existed on high pressure turbine inlet piping in Unit 2 Turbine Building EL 732.
  - Degraded insulation and incomplete coverage of insulation existed on 2-VLV-6-1408 in Unit 2 Turbine building EL 732.
  - Insulation degraded was noted in 2A2 MSR low pressure enclosure in Unit 2 Turbine Building EL 732.
  - Insulation was not fitted completely to steam line on Main Steam Loop 3 in Turbine Building EL 706 Unit 1.

Without timely intervention to address degraded material conditions, plant equipment reliability could deteriorate and potentially impact plant safety.

Recommendation: The plant should place a higher priority on evaluating and improving the material condition of equipment commensurate with its safety significance.

IAEA Bases:

SSR-2/2

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

7.12. The operating organization shall be responsible for ensuring that the identification and labelling of safety equipment and safety related equipment, rooms, piping and instruments are accurate, legible and well maintained, and that they do not introduce any degradation.

5. TECHNICAL SUPPORT

5.1 ORGANIZATION AND FUNCTIONS

The plant has established and implemented a comprehensive seasonal preparation program. This process ensures that the plant identifies any issue that could challenge safe and reliable operations during winter and summer periods. Readiness milestones starting six months ahead of the considered period are defined. The plant cross-functional seasonal readiness team performs walk-downs, inspections, and tracks the work scope through the work management process. Recovery and contingency plans are developed to ensure milestones are completed as necessary. Both internal site critique and nuclear fleet senior management challenge meetings are held to provide a validation of the readiness, at a senior leadership level. The team recognized this as a good performance.

Engineering staff turnover is high, as internal position changes and retirement have increased over the past three years. The plant has set up a knowledge transfer program to ensure that younger engineers will capture knowledge and skills from experienced departing employees. A process has been implemented to identify, prioritize, capture and transfer knowledge of skilled workers which might be lost when the employee departs. A guided interview between the manager and the employee takes place well ahead of the expected departure date in order to identify critical skills. Transferred knowledge is documented and retained by Human Resources. The team recognized this as a good performance.

The plant has established an Engineering Leadership Oversight Review (ELOR), at a 4-6 weeks frequency to foster an environment of teamwork, alignment and collaboration between corporate engineering and the plant's engineering management teams. This helps to ensure precise engineering support for safe and reliable operations of the units. The review covers all the engineering scope including systems/components reliability, design, programs, computer and reactor engineering. All items are assigned, documented and tracked with a follow-up at the next ELOR meeting. The team recognized this as a good performance.

The plant has faced many equipment reliability challenges in recent years. An Equipment Reliability Recovery Plan (ERRP) has been set as part of the leadership program and led to improvement of the plant performance in recent months. However, weaknesses remain, mainly in substandard material condition and critical component preventive maintenance scheduling. Key performance indicators have been developed and are tracked on a weekly basis. The team encouraged the plant to set more challenging targets.

5.2 PERIODIC SAFETY REVIEW

Safety reviews are carried out every 5 years, or more often if necessary, to consider how modifications and procedure changes within the period have affected the Updated Final Safety Analysis Report. Reviews are also carried out in response to the Nuclear Regulatory Commission requirements which prescribe plant enhancements. However, the plant does not perform a full scope periodic safety review. The team made a suggestion in this area.

5.7 PLANT MODIFICATION

The team identified that some temporary equipment or items adjacent to safety related equipment were not properly restrained. The most significant examples were scaffolding in contact with ERCW pumps, scaffold erected next to a safety injection pump, only secured with metallic wires, and a ladder close to a charging pump not robustly restrained. The team made a suggestion in this area.

DETAILED TECHNICAL SUPPORT FINDINGS

5.2 PERIODIC SAFETY REVIEW

5.2(1) Issue: Although the plant implements an acceptable alternative to a full scope Periodic Safety Review it does not regularly re-evaluate all safety factors defined for Periodic Safety Reviews.

The team noted the following:
- The plant carries out specific safety reviews and updates specific documentation such as the Final Safety Analysis report, as required by national regulations.
- The plant does not perform a PSR every ten years for covering the whole intended period of operation in the manner indicated by IAEA Safety Standards. However, the plant does implement an acceptable alternative to PSRs that deal with specific safety issues, significant events and changes in safety standards and operating practices as they arise (consistent with IAEA SSG-25, Paragraph 2.8). The Integrated Regulatory Review Service Mission (IRRS) mission to the United States concluded that the regulatory programs in the nation "…are intended to ensure that the goals of the periodic safety review are met and that provide adequate protection to the health and safety of the public, as required by the Atomic Energy Act."

As the plant does not regularly re-evaluate all safety factors as defined in IAEA guidance for PSR requirements, it may miss opportunities to identify potentially important safety improvements to enhance plant performance.

Suggestion: The plant should consider benchmarking its specific safety reviews against best international practices to ensure completeness of their overall safety assessments.

IAEA Bases:
SSR-2/2

Requirement 12: Systematic safety assessments of the plant, in accordance with the regulatory requirements, shall be performed by the operating organization throughout the plant's operating lifetime, with due account taken of operating experience and significant new safety related information from all relevant sources.

4.44. Safety reviews shall be carried out at regular intervals. Safety reviews shall address, in an appropriate manner, the consequences of the cumulative effects of plant ageing and plant modification, equipment requalification, operating experience, current standards, technical developments, and organizational and management issues, as well as siting aspects. Safety reviews shall be aimed at ensuring a high level of safety throughout the operating lifetime of the plant.

SSG-25

2.4. PSR provides an effective way to obtain an overall view of actual plant safety and the quality of the safety documentation, and to determine reasonable and practical modifications to ensure safety or improve safety to an appropriate high level. To do this, the PSR needs to identify any lifetime limiting features at the plant in order to plan future modifications and to determine the timing of future reviews.

2.5 On the basis of international experience, it is reasonable to perform a PSR about ten years after the start of plant operation, and then to undertake subsequent PSRs at ten year intervals until the end of operation. Ten years is considered to be an appropriate interval for such reviews in view of the likelihood, within this period, of the following:

- Safety until the next PSR or, where appropriate, until the end of planned operation (that is, if the nuclear power plant will cease operation before the next PSR is due);
- The extent to which the plant conforms to current national and/or international safety standards and operating practices;
- Safety improvements and timescales for their implementation;
- The extent to which the safety documentation, including the licensing basis, remains valid.

5.7 PLANT MODIFICATIONS

5.7 (1) Issue: Some temporary equipment and items are not properly restrained to ensure that their potential impact on safety related equipment is minimized during seismic events.

The team noted the following:

- The plant has no clear and easy to understand requirements for securing scaffolding to prevent potential impact on safety related equipment in the event of an earthquake (e.g. securing top and bottom of the erection).
- In the Essential Raw Cooling Water (ERCW) pump room, an unsecured scaffolding was in contact with pumps.
- A scaffold was stored next to a Safety Injection-pump, and it was only secured with metallic hard wires.
- A ladder adjacent to a charging pump was not robustly restrained.
- An unsecured ladder was in contact with the ERCW strainer 2A pipework.
- A ladder next to ERCW pump K-A was not properly secured against potential seismic event.
- In Unit 1 Auxiliary Building, EL 690, ladders were not seismically restrained to the wall.
- Several items of equipment were stored just in front of switchgear cubicles (6.9kV unit board 1A for reactor coolant pumps) in the area marked ‘unit trip hazard’ without being restrained.
- Four computer monitors were not secured on a table which was one meter away from the radiation monitor panel and about two meters away from the diesel generator control panel and electrical panel in the Main Control Room (MCR).
- Two chairs were placed about one meter away from the radiation monitor panel and about two meters away from the diesel generator control panel and electrical panel in MCR.
- There was a temporary radiation protection shield installed on the pipework above the water chemistry sample collection point without proper fixing.
- A free-standing chair was stored close to ERCW strainer 1-A.

Without properly restraining temporary equipment and items in the vicinity of safety related equipment, the risk of damage could increase during a seismic event.

Suggestion: The plant should consider improving the control and restraint of temporary equipment and items to ensure that their potential impact on safety-related equipment is minimized during seismic events.

IAEA Bases:

SSR-2/2

Requirement 10: Control of plant configuration

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

Requirement 13: Equipment Qualification

4.48: Appropriate concepts and the scope and process of equipment qualification shall be established, and effective and practicable methods shall be used to upgrade and preserve equipment qualification.

GSR part 4

R13: Assessment of Defence In Depth

4.21. In the assessment of the safety functions, it shall be determined whether they will be performed with an adequate level of reliability, consistent with the graded approach (see Section 3). It shall be determined in the assessment whether the structures, systems and components and the barriers that are provided to perform the safety functions have an adequate level of reliability, redundancy, diversity, separation, segregation, independence and equipment qualification, as appropriate, and whether potential vulnerabilities have been identified and eliminated.

SSG-25

5.40. Plant equipment important to safety should be properly qualified to ensure its capability to perform its safety function under postulated service conditions, including those arising from external events and accidents (such as a Loss of Coolant Accident, High energy line breaks and seismic or other vibration conditions) in a manner consistent with the safety classification.

NS-G-2.13

5.33. Plant walk downs are one of the most significant components of the seismic safety evaluation of existing installations... Plant walk downs should be performed within the scope of the seismic safety evaluation programme… identifying other in-plant hazards, such as those related to temporary equipment (scaffolding, ladders, equipment carts, etc.); and identifying the ‘easy fixes’ that are necessary to reduce some obvious vulnerability, including interaction effects…

NS-G-2.4

2.12. The description of the structure and of the functions to be performed by the individual departments in the operating organization, on and off the site, and by the individual persons in each department, as well as the lines of responsibility, authority and communication, should be unambiguous and should leave no scope for improvisation.

6. OPERATING EXPERIENCE FEEDBACK

6.4. SCREENING OF OPERATING EXPERIENCE INFORMATION

The criteria used for screening, categorizing and prioritizing events do not always ensure that all events are assessed to a depth commensurate with their potential safety significance. There is little guidance to help perform the screening consistently. Non-domestic Operating Experience (OE) is screened out and as a result the plant has not taken any corrective action based on the screening of non-domestic OE feedback from prior years. The team also found recurring deficiencies in the documentation of the screening decisions. The team made a recommendation in this area.

6.5. ANALYSIS

The team found several deficiencies related to the investigation of events and to the corrective actions. Apparent cause analyses have been discontinued, with the exception of equipment apparent cause evaluations, and replaced by more basic investigations that lack some expected attributes. In some cases, improvement opportunities related to organizational, programmatic or human performance aspects are not integrated into the conclusions and did not lead to corrective actions. Adverse trends identified by the plant were not always investigated with the necessary depth. Deficiencies were noted in terms of quality and monitoring of corrective actions and root cause analyses. A number of cases were found where better analysis of OE would have helped the plant to prevent events or to solve longstanding issues. The team made a recommendation in this area.

6.7. USE OF OPERATING EXPERIENCE

Management expectations regarding the use of internal and external operating experience are not always clear and effectively communicated. Non-domestic OE is not consistently used, and the team encouraged the plant to clarify its expectations regarding use of internal and external OE, including significant non-domestic lessons learned.

6.9. ASSESSMENT AND INDICATORS OF OPERATING EXPERIENCE

The team noted that self-assessments performed by the plant Performance Improvement (PI) group were consistently conducted in a very systematic, comprehensive and rigorous way and this has been an effective tool for identifying issues in the PI programme. The team recognized this as a good performance.

DETAILED OPERATING EXPERIENCE FINDINGS

6.4. SCREENING OF OPERATING EXPERIENCE INFORMATION

6.4(1) Issue: The plant screening of operating experience does not always ensure that issues are categorized and prioritized according to their safety significance and the screening process is not consistently documented.

The team noted the following:

- The concept of 'Level of Effort' was introduced in December 2014 to decide the level of event analysis to be performed. As a result, some events with high actual or potential consequences and high risk of recurrence may be analysed without Root Cause Analyses (RCA).
- The team found 8 recent events that had been assessed by the plant to have a high potential or actual safety significance, for which no RCA had been performed.
- The screening of condition reports done by the plant was based partly on an assessment of the actual or potential consequence and of the risk of recurrence of the event. This assessment was done using a non-robust method with little guidance. The plant does not use probabilistic risk assessment for assessing conditional core damage frequency to support the screening decision.
- Non-domestic OE is only captured in the industry daily download that is distributed to site OE coordinators for applicability review.
- From 2015 to August 2017, the plant did not take any corrective action based on the screening of non-domestic OE feedback. Feedback on about 20 non-domestic events is received per day, but they are screened out by the pre-screening done at the corporate level.
- The team found, in a sample of 15 events of level 1 or 2 significance, no records of the screening decision (decision matrix and critical thinking) for 10 events.
- Another five events of level 1 or 2 were found to have incomplete, erroneous, or ambiguous records of the screening decision (decision matrix and critical thinking).
- The plant had a fleet objective to have at least 75% of all condition reports closed at the screening step, within one or two working days, with or without corrective action.

Without adequate categorization of operating experience during the screening process, learning opportunities could be missed and events could recur.

Recommendation: The plant should improve screening of operating experience to ensure that issues are categorized and prioritized according to their safety significance and the screening process is consistently documented.

IAEA Bases:

SSR-2/2

5.28. Events with safety implications shall be investigated in accordance with their actual or potential significance. Events with significant implications for safety shall be investigated to identify their direct and root causes, including causes relating to equipment design, operation and maintenance, or to human and organizational factors.

NS-G-2.11

3.1. Screening of event information is undertaken to ensure that all significant matters relevant to safety are considered and that all applicable lessons learned are taken into account. The screening process should be used to select events for detailed investigation and analysis. This should include prioritization according to safety significance and the identification of adverse trends.

3.6. Events should be screened by a suitable multidisciplinary group of plant personnel...

3.8. The results of screening … should be recorded for evaluation in subsequent periodic self-assessments or peer reviews.

5.1 The safety significance of the event, which includes its potential consequences, determines the depth of the cause analysis necessary and subsequently determines the type of corrective actions and the time limit for their implementation.

6.5. INVESTIGATION AND ANALYSIS

6.5(1) Issue: Plant event analyses and corrective actions are not always effective enough to minimize the risk of event recurrence.

The team noted the following:

- During the 21st Outage of Unit 1, the outage collective dose exceeded its target by 48%. The associated Root Cause Analysis (RCA) used no basic RCA tool (barrier analysis, task analysis, change analysis, event and causal factor chart, etc.), only interviews and checklists. Conclusions from safety culture and organizational effectiveness checklists were not integrated into the causes. Some corrective actions (CA) were not Specific, Measurable, Achievable, Relevant and Time-bound (SMART). The focus had been on finding out how to clean the reactor coolant system rather than on finding the underlying organizational causes. A large number of CAs was to perform more analyses to continue the investigation. There was no mention of the immediate actions taken.
- For some types of RCA and for all Apparent Cause Analyses (ACAs), the plant had the freedom to do no extent of cause, no extent of condition, no review of past OE, no CA effectiveness review, and to bypass the review by the Management Review Committee (MRC).
- ACAs have been discontinued and replaced by basic investigations, with the exception of 'equipment ACAs'. These investigations provided some general conclusions but had no statement of cause. As a result, causes were often unclear. CAs were not always aligned with the conclusions.
- The ACA qualification and training have been discontinued. There is no training dedicated to investigation of level 2 condition reports.
- Almost all level 2 event reports did not analyse and describe the actual or potential consequences of the incident on nuclear safety.
- Existing OE was very rarely reviewed for level 2 events and lower ones, and immediate or temporary actions were very rarely mentioned.
- Among the few recent reports that have reviewed past applicable OE, at least four indicated that the consideration of relevant OE before the incident would have been helpful, and could have possibly prevented some incidents. These incidents included one spurious safety injection and one reactor trip.
- Two reactor trips occurred within 3 days in 2015 for similar reasons, which were repeated events.
- An ACA was drafted after the last outage of unit 1 between Nov 2016 and Jan 2017 to analyse rework and craftsmanship issues. In March 2017, an adverse trend was declared on craftsmanship for other deficiencies, but the condition report was closed with no corrective action because of the existing ACA. No effectiveness review was launched to check whether the adverse trend had been resolved.
- An ACA was drafted following the detection of an adverse trend on mispositioning events in May 2017. No effectiveness review was generated to check whether the adverse trend had been resolved, even though one was requested. The report mentioned no conclusion on the causes. No CA was created for the main cause group (procedure use and adherence). An extent of condition was performed for bump hazards and a long list of possible bump hazards were identified, however the report did not mention whether any CA was developed for this.
- The RCA associated with an unavailability of the fire suppression system lacked specific criteria for determining the effectiveness of the CAs.

- Several detailed procedures had recently been combined into a significantly less descriptive procedure which now refers to guidance material such as training, checklists and other reference materials, which do not need to be strictly followed.
- Assessing the extent of condition is only mandatory for some type of RCAs. The decision to do an extent of condition for other event categories was not reviewed formally by the Plant Screening Committee (PSC) or the MRC as it did not appear in the package reviewed during the meeting.
- There were two longstanding recurring technical issues at the plant, which had not been solved despite numerous Condition Reports (CRs) created, i.e., cracks in batteries and fan belt tensioning. External OE is available for these issues and solutions have been available for decades.
- There was no Human Factors Specialist included in the RCA analysis team.

  During a recent self-assessment performed by the plant, deficiencies were found in 47% of level 1 and 2 CRs reviewed. It included cases where organizational or human performance checklists were requested but were missing in the incident reports, 15 CRs with CAs closed but not actually performed or inadequately performed, and 16 trend-based reports and one RCA with the expected CA effectiveness review missing.
- In four CRs, some clearly identified organizational, programmatic and/or human performance issues have not been addressed by CAs.
- Some level 2 CRs had CAs that were not SMART.
- There was no guideline about the maximum number of extensions of CA due dates. Some examples of old CAs:
  - CA 379581-004 (ACA): 7 extensions, age 2205d.
  - CA 166884-020 (RCA): 2 extensions, age 2530d.
  - CA 109884-022 (ACA): 4 extensions, age 661d.
  - CA 655763-036 (RCA): 4 extensions, age 1417d.
  - CA 162711-012 (ACA): 4 extensions, age 2330d.

Without effectively conducting event investigation and implementing corrective actions, the risk of event recurrence could increase.

Recommendation: The plant should improve the effectiveness of event investigation and corrective action implementation to minimize the risk of event recurrence.

I

AEA Bases:

SSR-2/2

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. Corrective actions shall be prioritized, scheduled and effectively implemented and shall be reviewed for their effectiveness.

5.28. Events with safety implications shall be investigated in accordance with their actual or potential significance. Events with significant implications for safety shall be investigated to identify their direct and root causes, including causes relating to equipment design, operation and maintenance, or to human and organizational factors. The results of such analyses shall be included, as appropriate, in relevant training programmes and shall be used in reviewing procedures and instructions.

NS-G-2.11

4.3. The level of the investigation carried out should be commensurate with the consequences of an event and the frequency of recurring events.

4.8. At the plant level … several follow-up activities should be undertaken after the analysis of an event. These activities comprise … monitoring of the implementation of corrective actions and assessment of their effectiveness.

5.2. The development of recommended corrective actions following an event investigation should be directed towards the root causes and the contributory causes, and should be aimed at strengthening the weakened or breached barriers that failed to prevent the event.

6.10. Once an abnormal trend has been identified it should be treated as an event... Corrective actions should be focused on addressing the causes... Subsequent follow-up actions should be taken to verify that the adverse trend has been corrected or to modify the original corrective actions.

7. RADIATION PROTECTION

7.1. ORGANIZATION AND FUNCTIONS

The plant has established goals and indicators related to radiation protection. These showed recent adverse trends on collective radiation exposure for Unit 1 and prompted a recovery plan. However, the plant does not have lower tier performance indicators that could detect adverse trends in a timely manner. Therefore, the team encouraged the plant to improve performance indicators at the lower level.

7.2. RADIATION PROTECTION POLICY

The plant uses radiation units (i.e., Rem, Rad and Ci), which is different from the commonly used radiation units (i.e., Sv, Gy and Bq) internationally. The team encouraged the plant to review and improve in this area.

The plant has established a system to assign alarm settings on personal electronic dosimeter for work inside radiation controlled areas. However, weaknesses in setting reasonable dose and dose rates for the work according to specific radiation sources prevents the use of dose constraints as required. Radiation hazard communications in the plant do not provide the radiation workers with prompt and visible information, potentially reducing their situational awareness. Lastly, the communication between the radiation protection organization and the other departments is limited. This may prevent other organizations like design engineering, chemistry and operations taking responsibility for dose reduction at the plant. The team made a recommendation in this area.

7.3. RADIATION WORK CONTROL

The layout and access control of some areas in the radiation controlled area is not optimal to effectively control the spread of contamination. Examples include the sample area for the refueling water storage tank and the layout of the hot chemistry laboratory. The layout of the entry and exit area for the radiation control area is not optimal to ensure effective access control and to minimize the likelihood of the spread of contamination. The team made a suggestion in this area.

DETAILED RADIATION PROTECTION FINDINGS

7.2. RADIATION PROTECTION POLICY

7.2(1) Issue: Dose constraints, postings of radiation levels and communication within the plant organization were not always effectively used to ensure radiation situational awareness at the plant and to keep dose As Low As Reasonably Achievable (ALARA).

The team noted the following:

- Alarm set points for Radiation Work Permit (RWP) were driven by a corporate procedure, where it was stated to use 125% of the estimated dose for setting alarm set points per entry. For all the RWPs reviewed, the real doses and dose rates found in the field were much lower than the alarm settings. For example, on RWP 17222302 for scaffolding work, the dose alarm set point was 32 mRem; 213 workers received less than 1 mRem; 3 workers received about 15 mRem and the average dose was 0.9 mRem.
- Normally in the plant, a single RWP covered several tasks with different radiological conditions. The settings to apply dose and dose rate constraints for this RWP were governed by the task with the highest doses and dose rates.
- The plant did not set alarms for time in controlled areas. In one instance, a person was recorded inside the controlled area for more than 9 hours.
- The following were identified when the ALARA plan for source term reduction of the plant was reviewed:
  - The ALARA corrective action plan had no formal approval and review signatures;
  - One person was responsible for 20 actions and other two were responsible for 2 other actions. These three people were members of the Radiation Protection (RP) organization. No responsibilities were assigned for other organizations, such as operations, design engineering, plant management, work management or outage coordination.
  - The source reduction team was expected to meet every 2 weeks; no attendees list was recorded. The matters discussed were not formally recorded.
  - Operations did not normally increase coolant water purification before outages, which could reduce the outage source term, by increasing the let-down flow to the chemical and volume control system. The reasons were not clearly communicated to the ALARA committee.
- On the refuelling floor in the auxiliary building, a contaminated vacuum cleaner was tagged. However, the tag with radiation levels was behind the equipment and was not visible to workers passing or stopping nearby.
- At the entrance of rooms assigned as radiological controlled areas outside of main Radiation Controlled Area (RCA), there were no caution signs posted on the doors displaying radiation hazards, instead they were posted inside the rooms. Outside the room, on the wall, there was a map showing values of radiation surveys without a radiation caution sign but the map was small and difficult to read.
- The plant did not use radiation caution signs on the doors of the rooms inside the RCA and did not post any visible quantitative information about radiation levels and contamination. Posted survey maps were small and difficult to read.
- Outside a locked high radiation area, the radiation levels at the boundaries were not posted and this area was easily accessible. It was verbally communicated that the radiation level in this area was more than 20 mRem/h (200 microSv/h).
- A pipe with temporary shielding near the sample collection panel for the refuelling water storage tank was not fenced, and did not have radiation level postings.

– The inventory list found in the source signature book was from May 2016. When this was pointed out by the team, an updated list was added to the source signature book.

Without effective use of dose constraints, postings of radiation levels, and communication within the plant organization, the plant may be challenged to prevent unnecessary radiation doses.

Recommendation: The plant should improve the use of dose constraints, postings of radiation levels and communication within the plant organization to keep dose as low as reasonably achievable.

IAEA Bases:

GSR Part 3

1.22. Dose constraints and reference levels are used for optimization of protection and safety, the intended outcome of which is that all exposures…are as low as reasonably achievable…Dose constraints are set separately for each source … serve as boundary …for the purposes of optimization of protection and safety. Dose constraints are not dose limits: exceeding a dose constraint does not represent non-compliance with regulatory requirements, but it could result in follow-up actions.

1.23. … dose constraint is a tool to be established and used in the optimization of protection and safety by the person or organization responsible for a facility or an activity… The setting of the dose constraint needs to be considered in conjunction with other health and safety provisions and the technology available.

1.25. The ICRP recommends a range of doses spanning two orders of magnitude within which the value of a dose constraint or reference level would usually be chosen. At the lower end of this range, the dose constraint or reference level represents an increase, of up to about 1 mSv…

1.26. Dose constraints or reference levels of 1–20 mSv would be used when the exposure situation — but not necessarily the exposure itself — usually benefits individuals. …

2.52. The principal parties… shall take into account human factors and shall support good performance and good practices to prevent human and organizational failures, by ensuring …

(a) Sound ergonomic principles … to facilitate the safe operation and use of equipment…

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.

3.128. Registrants and licensees, in cooperation with employers where appropriate:

(a) Shall apply the relevant requirements of these Standards in respect of public exposure for visitors to a controlled area or a supervised area...

(c) Shall provide adequate information and instructions to visitors before they enter a controlled area or a supervised area, so as to provide for protection and safety for visitors and for other individuals who could be affected by their actions;

(d) Shall ensure that adequate control is maintained over the entry of visitors to a controlled area or a supervised area, including the use of signs for such areas.

SSR-2/2

4.1. Managers shall promote an attitude of safety consciousness among plant staff .

4.2. … expectations … for safety performance shall be clearly communicated …shall be ensured … are understood by all those involved...

5.11. … radiation protection programme shall ensure …doses … are as low as reasonably achievable.

5.13. All plant personnel shall understand and acknowledge ….so that they are aware of radiological hazards and of the necessary protective measures.

5.16. The radiation protection programme shall ensure control over radiation dose rates … It also addresses plant chemistry activities … to maintain these doses as low as reasonably achievable.

8.11… Coordination shall also be maintained between maintenance groups, and operations groups and support groups (e.g. … radiation protection, …

NS-G-2.4

3.20. …Departmental goals and objectives should be co-ordinated among the departments to ensure that they are consistent and mutually supportive and reflect management’s priorities.

NS-G-2.7

2.4. “In relation to exposures from any particular source within a practice…protection and safety shall be optimized …within the restriction that the doses to individuals delivered by the source be subject to dose constraints” .. In a nuclear power plant, protection and safety should be optimized with regard to occupational exposure to any particular source or any particular task in the plant...

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. 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.

3.67. … Firstly, removal or reduction in intensity of the source of radiation should be considered. ...

Methods of dose reduction that should be considered include:

(a) reducing radiation levels in work areas, for example, by the use of temporary shielding;…

(c) reducing working time in controlled areas;…

(f) identifying low dose areas where workers can go without leaving the controlled area if their work is interrupted for a short time.

7.3. RADIATION WORK CONTROL

7.3(1) Issue: The layout and access control of some areas in the radiation controlled area are not optimal to effectively control the spread of contamination.

The team noted the following:

- The sample area for the refuelling water storage tank was not prepared in an optimal manner; there was no nearby bin (within 50 meters) to collect used gloves and lab coats, no procedure holder to free hands from holding written procedures, and the working area was not fenced.
- The layout of the hot chemistry laboratory made it difficult to set radiological barriers and decontaminate areas.
- The contaminated area at the refuelling floor was not fenced at the entrance point when not being used.
- The turnstile for entering the RCA did not prevent people leaving without using the installed monitors.
- The RCA layout allowed the possibility of exiting without passing through the contamination portal monitors.
- At the exit of the RCA, the electronic dosimeter reader for logging out was not interlocked.
- People were observed logged in but were not physically inside the RCA.
- The procedure for controlling Locked High Radiation Area (LHRA) keys was not clear in defining active LHRA and potential LHRA. The keys for active LHRA and potential LHRA were kept together in the same locker.

Without optimal layout and access control of some areas in the radiation controlled area, the risk of contamination spread could increase.

Suggestion: The plant should consider improving the layout and access control of some areas in the radiation controlled area to optimize control of contamination.

IAEA Bases:
GSR Part 3

3.88. … licensees shall designate as a controlled area any area …required for:

(a) Controlling exposures or preventing the spread of contamination in normal operation;

(b) Preventing or limiting the likelihood and magnitude of exposures in anticipated operational occurrences and accident conditions.

3.90. Registrants and licensees:

(a) Shall delineate controlled areas by physical means …

...

(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.

(e) Shall restrict access to controlled areas by means of administrative procedures such as the use of work permits, and by physical barriers, which could include locks or interlocks, the degree of restriction being commensurate with the likelihood and magnitude of exposures.

NS-G 2.7

3.5. Controlled areas are required to be delineated and entry to them is required to be restricted. The demarcation of controlled areas should utilize existing structural boundaries where practicable, provided that the radiological conditions meet the relevant requirements…

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 … 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.

3.13. Before items are removed from any contamination zone, and in any case before they are removed from controlled areas, they are required to be monitored as appropriate and suitable measures should be taken to avoid undue radiation hazards.

3.43. Preparation of the work area may be necessary, for example by: cordoning it off and posting warning signs; laying down temporary coverings to retain contamination; and providing local changing areas for protective clothing, solid waste bins, additional radiation monitors, temporary radiation shielding or ventilation.

8. CHEMISTRY

8.2. CHEMISTRY PROGRAMME

The plant has adopted multiple methods to communicate chemistry information to workers. The Chemistry function is involved in trend review meetings for various systems including primary, secondary and auxiliary. The evaluation and trending of important chemistry parameters from the Chemistry Data Acquisition System (CDAS) and communication with various plant groups are effective ways to assess the efficiency of chemistry control and in optimizing chemistry in plant systems. The team recognized this as a good performance.

The team observed that the plant does not consistently maintain the chemistry monitoring equipment nor implement the chemistry surveillance programme to ensure the accurate control of plant parameters. The team found that the facilities and equipment were not always adequate for use in normal and accident conditions. Some laboratory equipment was not always in good condition to support high quality analysis. The team made a suggestion in this area.

The team identified that plant chemicals and other substances were not always properly labelled. The plant does not apply chemistry controlled labels for bulk chemicals used for the primary and secondary side or other bulk chemicals when they arrive in the storage area. Some chemicals in cabinets used by maintenance department and some oil drums were not properly labelled. The team found that the expiration date information was missing on the labels from some bulk warehouse chemicals. The process for compliance confirmation sampling was only done for liquid process chemicals and the process chemistry control for some chemical suppliers was not conducted to ensure that potentially harmful impurities do not enter process systems. The team made a recommendation in this area.

DETAILED CHEMISTRY FINDINGS

8.2 CHEMISTRY PROGRAMME

8.2(1) Issue: The chemistry surveillance programme was not always implemented effectively to ensure the precise monitoring of plant chemistry parameters.

The team noted the following:

- Secondary side chemistry monitoring:
  - At Unit 2, 10 out of 34 on-line measurement parameters were not available due to problems with the Hot Well (HW) sample booster pumps and Martek analyser.
  - The sampling point in Unit 2 HW A had been out of service since 31 December 2015. A similar condition existed in Unit 1.
  - Even though the Unit 1 Feed Water (FW) pH on-line instrument showed a degrading trend from 1 October 2016 to 21 November 2016, the necessary actions were not taken to verify the instrument reading.
  - On-line instruments which were not working properly (Unit 1 -HW A, B; Unit 2-HW A, B) were left in operation mode displaying incorrect values on the analysers**.** The plant did not tag instruments out of service to prevent readings being considered as valid during plant walk downs.
  - Multiple (4) Quality Deficiency Investigations (QDI) were initiated in 2017 for repeated challenges related to dissolved oxygen instruments.
- Chemistry surveillance:
  - A technician did not document all interim results (such as calculation of mass of concentration of corrosion products) when calculating micro filter iron concentration. Only the final result was recorded. Verification of the calculation data afterwards was not possible.
  - A Condition Report (CR) was discussed during a work week critique and feedback T+1 meeting because some oil leaked from the bridge crane into the Spent Fuel Pool (SFP), increasing the sulphate concentration over the administrative limit. At the end of the mission the SFP concentration remained above the administrative limit.
- Sampling:
  - Sampling lines in the sampling cabinet were covered by boric acid deposits at the boric acid transfer area in the auxiliary building at elevation 690.
  - One of the Swagelock connecters in the lines to the boric acid transfer sampling point was covered by crystallised boric acid.
  - The Refuelling Water Storage Tank (RWST) sample hood had boric acid crystals in the screen and on the sampling line.
- Housekeeping and material condition:
  - The surface of the primary chemistry laboratory weight scale had boric acid crystals on it due to spillage from pouring samples into sample containers.
  - The cooling water supply valve in Hood C was leaking. The line supplies water to chemistry apparatus.
  - The light was broken in the fume hood used to take samples from the RWST.
  - The secondary laboratory had several pieces of abandoned equipment.
  - The fume hood sash in the primary chemistry laboratory did not work properly.
  - The radioactive sources locker in the hot laboratory was used to store samples in a disorganized manner.

Without effective implementation of the plant chemistry surveillance programme, the precise monitoring and control of plant chemistry parameters could be compromised.

Suggestion: The plant should consider enhancing the chemistry surveillance programme to precisely monitor plant chemistry parameters.

IAEA Bases:

SSR2/2

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.

7.15. The chemistry programme shall include chemistry monitoring and data acquisition systems. These systems, together with laboratory analyses, shall provide accurate measuring and recording of chemistry data and shall provide alarms for relevant chemistry parameters. Records shall be kept available and shall be easily retrievable.

7.16. Laboratory monitoring shall involve the sampling and analysis of plant systems for specific chemical parameters, concentrations of dissolved and suspended impurities, and radionuclide concentrations.

SSG-13

6.8. Consideration should be given to the use of on-line monitoring of control parameters as the preferable monitoring method for evaluating chemistry conditions in plant systems.

6.9. Laboratory analysis should be considered a necessary complement in the diagnosis of chemistry problems, to verify the accuracy of on-line monitors and whenever it is either not possible or not reasonable to apply on-line monitoring.

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

6.33. Industrial safety (provision of fume hoods for ventilation, appropriate storage of flammable solvents and hazardous materials, and flammable and other gases, and provision of safety showers for personnel, as well as personal protective equipment and first aid kits) and radiological safety (proper radiation shielding and contamination control facilities) should be ensured. All laboratory and work practices should be carried out in accordance with industrial safety standards and the principle of optimization of protection (and safety) [3, 14].

6.41. Appropriate consideration should be given to the need for correct sampling conditions, as one of the most important factors affecting the accuracy and reliability of measurement results is sampling, which is the first step of every analytical measurement. Account should be taken of delays in obtaining samples (due to, for example, the volume of the 'sampling line' for liquid samples) when using data obtained through on-line or laboratory measurements, and of specific sampling issues associated with obtaining representative soluble and particulate corrosion products.

6.42. Representative grab samples should be ensured by appropriate flushing of sampling lines, proper determination of the flow rate, cleanness of containers, and minimization of the risk of chemical contamination and loss of dissolved gases or volatile substances during sampling. A written procedure on sample collection should be made available.

8.2(2) Issue: Plant chemicals and other substances were not always properly labelled and controlled.

The team noted the following:

- The plant did not apply chemistry control labels to boric acid batches, hydrazine and ethanolamine (ETA) containers or other bulk chemicals when they arrived at the storage area.
- Some process chemicals on site did not have chemistry laboratory control labels.
- Liquid process chemicals were analysed only 1-2 times a year to confirm compliance with specifications given by the supplier. Boric acid used in the primary coolant was not analysed before concentrated boric acid solutions were prepared. The process chemistry control was not conducted to ensure that potentially harmful impurities do not enter process systems.
- One of the H_2O_2 tanks in the make-up water plant did not have a proper chemistry laboratory control label on it.
- At the storage building for secondary side bulk chemicals (hydrazine and ETA) the following deficiencies were identified:
  - Four 20 L bottles of hydrazine were not marked and labelled similarly to the original one. Not all safety related information was transferred to these smaller bottles.
  - On two hydrazine totes the expiration dates were missing from the labels.
  - On two ETA totes expiration dates were missing from the labels.
  - The Inhibitor Spectrum BD 1500 container at the Raw Cooling Water (RCW) injection skid did not have an expiration date on the label.
  - In the hydrazine storage building, 4 pails of biocide (oxidizer) did not have expiration dates on the label.
  - A one litre bottle of unknown liquid without a proper label was found in the Secondary side injection building.
  - The building used to store ETA was not marked with the chemical contents.
  - Pumps which were used to inject chemicals (ETA and hydrazine) into the secondary side were not clearly marked to enable prompt identification.
- In the diesel building, diesel drums and some chemicals in cabinets used by maintenance were not properly labelled to verify necessary approval. Similarly, in the turbine building (location 685, J-T6), there were oil drums without proper labelling of the contents.
- In the auxiliary building one 200 litre barrel of glycol did not have the required labels.

Without proper labelling and controlling of chemicals, the risk of intrusion of non-conforming chemicals or other substances into plant systems could increase.

Recommendation: The plant should improve labelling and controlling of plant chemicals and other substances.

IAEA Bases:

SSR2/2

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

SSG-13

9.5. The reagents and ion exchange resins used for any safety related system should be within the required specifications with regard to impurities and this should be verified before their use.

9.8. When receiving chemicals, the specified quality should be verified by chemical analysis and/or by a certificate and a chemical identification test.

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

9.10. When a chemicals s transferred from a stock container to a smaller container, the latter should be labelled with the name of the chemical, the date of transfer and pictograms to indicate the risk and application area. The contents of the smaller container should not be transferred back into stock container. Residues of chemicals and substances should be disposed of in accordance with plant procedures. The quality of chemicals in open stock containers should be checked periodically.

9. EMERGENCY PREPAREDNESS AND RESPONSE

9.1. ORGANIZATION AND FUNCTIONS

The plant has a comprehensive process in place for measuring and monitoring the overall performance of the Emergency Preparedness Plan. The comprehensive process allows the site, corporate emergency preparedness group and the nuclear quality assurance organization to predict performance and to rapidly identify both positive and negative trends. It also allows for rapid corrective actions of weaknesses and gaps and communication of those actions to the other sites. The team recognized this as a good performance.

9.2. EMERGENCY RESPONSE

For medical treatment of those individuals who are contaminated on the site in any situation the plant has signed agreements with two hospitals and proper decontamination areas are set-up within both hospitals. The plant Emergency Preparedness and Response personnel provide training to the medical staff once per year, based on a comprehensive training package. The team recognized this as a good performance.

9.3. EMERGENCY PREPAREDNESS

The Central Emergency Control Centre (CECC) is very well equipped with adequate and reliable communications systems. It is adequate in size, operable and habitable under emergency conditions. The CECC is appropriately organized, supplied with updated copies of documents (procedures, drawings, etc.), connected to the plant critical safety parameters and provided with two backup power supplies. The team recognized this as a good performance.

The team observed that some aspects of the emergency facilities and arrangements are not always adequate to support a comprehensive emergency response. Examples identified by the team include: some provisions and equipment are missing from Technical Support Centre and Operation Support Centre, assembly areas are not provided with Potassium Iodide (KI) pills and radiological monitoring equipment and there were no speakers for warning the personnel inside the containment when an emergency was declared. The team made a suggestion in this area.

The team observed some aspects of emergency training, drills and exercises were not always effectively conducted. Some of the concerns were related to the lack of site specific plant access initial and refresh training on emergency preparedness and response for normal workers, contractors and visitors and that the plant did not perform any emergency drill and exercise involving both units for a Beyond Design Basis Accident (BDBA). The team made a suggestion in this area.

DETAILED EMERGENCY PLANNING AND PREPAREDNESS

9.3. EMERGENCY PREPAREDNESS

9.3(1) Issue: Some aspects of the emergency facilities and arrangements do not support a fully comprehensive emergency response.

The plant follows national requirements and, in general, the emergency preparedness and response framework in the plant had been demonstrated to be mature and, to a great extent, in line with IAEA Safety Standards. However, the team noted the following:

- The Technical Support Centre (TSC) was not provided with:
  - stocks of food and Potassium Iodide (KI) pills.
  - monitoring of contamination at the TSC entrance.
  - backup power supply other than for the Integrated Computer System which has a backup power supply for approximatively 45 minutes.
  - voice recorder system to record designated phone calls and verbal communication in case of an emergency.
- The Operation Support Centre (OSC) and OSC staging area did not have:
  - back-up power supply.
  - filtered ventilation system.
  - earthquake qualification.
  - stocks of respiratory protection to be used by emergency entry teams.
  - voice recorder system to record designated phone calls and verbal communication in case of an emergency.
- The plant Radiological Emergency Plan (REP) does not consider multi-unit accidents.
- Assembly areas within the site were not provided with KI pills and radiological monitoring equipment.
- There were no loudspeakers for warning the personnel inside the containment should an emergency be declared.
- A cardboard box of unnecessary materials was stored in the back of a radiological emergency van along with necessary materials; the van’s fuel tank was half empty.
- The plant does not have a hotline for the family members of emergency workers to use to obtain or receive information during emergencies. However, the plant’s corporate organization has a hotline for such a purpose.
- The plant did not have any arrangements to provide psychological support or counselling for emergency workers.

Without adequately equipped emergency facilities and arrangements, the plant’s capability to cope with any credible emergency situation may be adversely affected.

Suggestion: The plant should consider improving some aspects of the emergency facilities and arrangements.

IAEA Bases:

GSR Part 7
Requirement 9: Taking urgent protective actions and other response actions

The government shall ensure that arrangements are in place to assess emergency conditions and to take urgent protective actions and other response actions effectively in a nuclear or radiological emergency

5.42. Arrangements as stated in para. 5.41 shall also include ensuring the provision, for all persons present in the facility and on the site, of:

(a) Suitable assembly points, provided with continuous radiation monitoring;
(b) A sufficient number of suitable escape routes;
(c) Suitable and reliable alarm systems and other means for warning and instructing all persons present under the full range of emergency conditions.

Requirement 16: Mitigating non-radiological consequences of a nuclear or radiological emergency and of an emergency response

The government shall ensure that arrangements are in place for mitigation of non-radiological consequences of a nuclear or radiological emergency and of an emergency response.

5.90. Arrangements shall be made for mitigating the non-radiological consequences of an emergency and those of an emergency response and for responding to public concern in a nuclear or radiological emergency. These arrangements shall include arrangements for providing the people affected with:

(a) Information on any associated health hazards and clear instructions on any actions to be taken (see Requirement 10 and Requirement 13);
(b) Medical and psychological counselling, as appropriate;
(c) Adequate social support, as appropriate.

Requirement 19: Analysing the nuclear or radiological emergency and the emergency response

The government shall ensure that the nuclear or radiological emergency and the emergency response are analysed in order to identify actions to be taken to avoid other emergencies and to improve emergency arrangements.

5.102. Arrangements shall be made to document, protect and preserve, in an emergency response, to the extent practicable, data and information important for an analysis of the nuclear or radiological emergency and the emergency response. Arrangements shall be made to undertake a timely and comprehensive analysis of the nuclear or radiological emergency and the emergency response with the involvement of interested parties. These arrangements shall give due consideration to the need for making contributions to relevant internationally coordinated analyses and for sharing the findings of the analysis with relevant response organizations. The analysis shall give due consideration to:

(a) The reconstruction of the circumstances of the emergency;
(b) The root causes of the emergency;
(c) Regulatory controls including regulations and regulatory oversight;
(d) General implications for safety, including the possible involvement of other sources or devices (including those in other States);
(e) General implications for nuclear security, as appropriate;
(f) Necessary improvements to emergency arrangements;
(g) Necessary improvements to regulatory control.

Requirement 24: Logistical support and facilities for emergency response

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.

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

6.25. For facilities in category I, emergency response facilities separate from the control room and supplementary control room shall be provided so that:

(a) Technical support can be provided to the operating personnel in the control room in an emergency (from a technical support centre).
(b) Operational control by personnel performing tasks at or near the facility can be maintained (from an operational support centre).
(c) The on-site emergency response is managed (from an emergency centre).

These emergency response facilities shall operate as an integrated system in support of the emergency response, without conflicting with one another’s functions, and shall provide reasonable assurance of being operable and habitable under a range of postulated hazardous conditions, including conditions not considered in the design.

SSR-2/2

Requirement 18: Emergency preparedness

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

5.8A. For a multi-unit nuclear power plant site, concurrent accidents affecting all units shall be considered in the accident management programme. Trained and experienced personnel, equipment, supplies and external support shall be made available for coping with concurrent accidents. Potential interactions between units shall be considered in the accident management programme.

GS-G-2.1

4.29. Consequently, the Requirements [2] (para. 4.51) require that, for these facilities, specific arrangements be in place to effectively implement urgent protective action for the people on the site. These arrangements should apply to all people in areas controlled by the operator, such as visitors or others (e.g. construction workers, fishermen).

5.5. Emergency facilities should be provided that are in accordance with Appendix VIII.

PROPHYLAXIS WITH STABLE IODINE

V.14. The uptake by the thyroid gland of radioiodine from inhalation can be reduced by the administration of certain amounts of stable (non-radioactive) iodine which saturates the thyroid. This is called stable iodine prophylaxis, thyroid blocking or iodine blockade.

V.15. To achieve maximum effectiveness, stable iodine must be administered before or soon after the intake of radioiodine. The effectiveness of the measure decreases rapidly with delay, and can be reduced to 50% or less if administered 6 hours after a single intake of radioactive iodine. The reduction in the dose to the thyroid gland is only about 20% if stable iodine is given 10 hours after intake, while it falls almost to zero if stable iodine is given 24 hours after the intake of radioiodine.

TABLE 13. URGENT PROTECTIVE ACTIONS FOR THREAT CATEGORY I AND II FACILITIES

Threat category I - Suggested protective action

General emergency:

- Promptly evacuate or provide special sheltering [a] for the public and nonessential workers on the site;
- Promptly evacuate or provide substantial sheltering [b] for the public in the PAZ (in all directions);
- For an emergency involving a nuclear reactor, provide stable iodine for thyroid blocking within the PAZ and UPZ;
- Recommend to the public within the UPZ that they remain indoors and listen to the radio or television for further instructions (in-place sheltering);
- Promptly conduct monitoring within the UPZ (including the shelters in the PAZ) to determine where OILs could be exceeded and to evacuate if appropriate;
- Restrict consumption of possibly contaminated food or water and provide instructions to protect food and water supplies and agricultural products;
- Restrict access to the evacuated area and areas where sheltering is recommended;
- Monitor the people evacuated and determine whether decontamination or medical treatment is needed.

EPR-METHOD-2003 – Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency

4.2.17. Logistical support and facilities (B5 elements)

B5.2 …….

Emergency facilities within the facility or UPZ should be suitably protected in order to control risk of radiation and other hazards (e.g. high temperatures, chlorine) to emergency workers and to prevent functions (e.g. dispatch of monitoring teams) from being jeopardized during postulated emergency conditions. Off-site facilities that are not protected against a radiological release (e.g. shielding and filters) should have backups beyond the UPZ. There should be provisions to continuously monitor radiological conditions and control of contamination within the facilities and for evacuation if warranted.

9.3(2) Issue: Some aspects of emergency training, drills and exercises were not always effectively conducted.

The team noted the following:

– The plant did not have site specific plant access initial and refresher training on emergency preparedness and response for normal workers, contractors and visitors.
– The plant did not perform any emergency drill and exercise involving both units for Beyond Design Basis Accident (BDBA).
– The plant did not perform unannounced emergency drill during weekends.
– There were several cases of Emergency Planning Training postponement. For example, the Orange Team Radiation Emergency Plan training drill was scheduled to be conducted on 22 March 2017, and has been postponed to 3 November 2017. The drill was rescheduled at the Senior Leadership and emergency preparedness team's discretion to accommodate plant needs.
– In one exercise the electrical task controller was pulled back from his controller duties in the exercise to work on the plant.
– The following shortfalls were identified on radiological emergency van training: personnel did not know which alarms were set on the personal alarming dosimeters, participants had difficulties using the van equipment, the participants did not switch on the radiological monitoring equipment to simulate real measurement and the participants did not pack and label the air samples taken (filters).

Without fully effective emergency training, drills and exercises, the plant's capability to cope with emergency situations could be adversely affected.

Suggestion: The plant should consider improving its emergency training, drills and exercise program.

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

5.4. For a site where several facilities in categories I and II are collocated, adequate arrangements shall be made to manage the emergency response at all the facilities if each of them is under emergency conditions simultaneously. This shall include arrangements to manage the deployment of and the protection of personnel responding on and off the site (see Requirement 11).

Requirement 25: Training, drills and exercises for emergency preparedness and response
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.

6.28. The operating organization and response organizations shall identify the knowledge, skills and abilities necessary to perform the functions specified in Section 5. The operating organization and response organizations shall make arrangements for the selection of personnel and for training to ensure that the personnel selected have the requisite knowledge, skills and abilities to perform their assigned response functions. The arrangements shall include arrangements for continuing refresher training on an appropriate schedule and arrangements for ensuring that personnel assigned to positions with responsibilities in an emergency response undergo the specified training.

6.29. For facilities in category I, II or III, all personnel and all other persons on the site shall be instructed in the arrangements for them to be notified of an emergency and of their actions if notified of an emergency.

6.30. Exercise programmes shall be developed and implemented to ensure that all specified functions required to be performed for emergency response, all organizational interfaces for facilities in category I, II or III, and the national level programmes for category IV or V are tested at suitable intervals. These programmes shall include the participation in some exercises of, as appropriate and feasible, all the organizations concerned, people who are potentially affected, and representatives of news media. The exercises shall be systematically evaluated (see para. 4.10(h)) and some exercises shall be evaluated by the regulatory body. Programmes shall be subject to review and revision in the light of experience gained (see paras 6.36 and 6.38).

6.31. The personnel responsible for critical response functions shall participate in drills and exercises on a regular basis so as to ensure their ability to take their actions effectively.

6.33. The conduct of exercises shall be evaluated against pre-established objectives of emergency response to demonstrate that identification, notification, activation and response actions can be performed effectively to achieve the goals of emergency response (see para. 3.2).

SSR-2/2
Requirement 19: Accident management programme
The operating organization shall establish, and shall periodically review and as necessary revise, an accident management programme.

5.8A. For a multi-unit nuclear power plant site, concurrent accidents affecting all units shall be considered in the accident management programme. Trained and experienced personnel, equipment, supplies and external support shall be made available for coping with concurrent accidents. Potential interactions between units shall be considered in the accident management programme.

NS-G-2.8
TRAINING FOR EMERGENCIES
4.28. All personnel who have specific duties in an emergency should be given continuing training in the performance of these duties. Firefighting drills should be included in the continuing training programme for plant personnel who are assigned responsibilities for firefighting.

4.43. A general training programme should also be provided for on-site staff who have no emergency duties, to familiarize them with the procedures for alerting personnel to emergency conditions. Similar training, or at the minimum a well-structured information briefing, should be provided to contractor personnel or other temporary personnel.

GS-G-2.1
6.9. On-site dose rates during an emergency at facilities in threat categories I, II and III may be very high (e.g. >10 Gy/h), and there is a risk of contamination by beta emitters and other hazardous conditions (e.g. emission of steam) in areas where staff action may be needed to

mitigate the consequences of the emergency. People responding on the site should therefore be provided with appropriate protective equipment and training.

6.16. Depending on the facility concerned there may be high dose rates, contamination by beta emitters or other hazardous conditions in areas where action by the staff is required to mitigate the consequences of the emergency. People responding on the site should therefore be provided with appropriate protective equipment and training.

TABLE 12. RESPONSE TIME OBJECTIVES

EPR-EXERCISE-2005
GENERAL SCENARIOS
…..
- Emergency (e.g. fire) initiated at night or on a weekend.

EPR-METHOD-2003
4.2.2. Identifying, notifying and activating (A2 elements)
A2.5 ……
Demonstrate through drills and exercises that classification, notification, activation and initial response can be performed fast enough to meet the response time objectives established by the threat assessment or as specified in Appendix 10.

4.2.18. Training, drills and exercises- (B6 elements)
B6.4 Staff responsible for critical response functions for a facility in threat category I, II or IV should participate in a training exercise or drill at least once per year (6.31).

10. ACCIDENT MANAGEMENT

10.1. ORGANIZATION AND FUNCTIONS

Recently the plant has developed, as part of its accident management program, an overall Emergency Management Guideline (EMG) flowchart, which provides a comprehensive overview of accident management related guidelines and other relevant documents and instructions. It is intended to be used for coping with extreme events or extensive damage to plant components to re-establish a command structure and to perform critical emergency support functions. The structured EMG flowchart allows responsible decision makers (Site Emergency Director or Senior Operations staff on Shift or other Senior Operations Personnel) to take the right decisions under various plant conditions that do not allow for more detailed planning in advance. The team recognized this as a good practice.

10.5. PLANT EMERGENCY ARRANGEMENTS WITH RESPECT TO ACCIDENT MANAGEMENT

The plant has an Emergency Response Organization (ERO) which consists of different groups allocated in Emergency Response Centres on-site and off-site with selected and well defined functions and responsibilities. In case of an emergency four different levels of control centres are established, with the responsibility for decision making by the on-site located Technical Support Centre (TSC) supported by the Operations Support Centre (OSC). The plant added an approach for diverse and flexible mitigation strategies named FLEX to cope with beyond-design-basis external events that may affect both units on the site simultaneously. FLEX strategies enable the plant to maintain or restore key safety functions for all units at a site, and thus provides additional flexibility to prevent a multi-unit accident progressing into a multi-unit severe accident. Beyond the typical FLEX equipment stored on-site (e.g. mobile pumps and diesel generators) or off-site (additional materials and equipment for longer-term response stored off-site in national Strategic Alliance for FLEX Emergency Response (SAFER) response centres) the plant stored one portable meteorological (MET) tower on-site and installed sixteen radiological off-site monitoring / sampling stations around the plant (16 sectors of approx. 22 degree each within 5 miles distance of the plant). This equipment is used by the TSC to support the assessment of off-site consequences in case of a severe accident. The team recognized this as a good performance.

10.7 CONTROL OF PLANT CONFIGURATION

The original development of generic Severe Accident Management Guideline (SAMG) in the United States was undertaken by several Owners Groups (BWROG, Westinghouse OG, Combustion Engineering OG, and Babcock &Wilcox OG) in the 1990s. The plant is a member in the PWR Owners Group (PWROG) and has developed its own plant specific SAMG based on the generic OG SAMG and updated and extended it twice. The latest update includes the integration of other strategies such as Extended Damage Mitigation Guidelines (EDMGs) and FLEX into the plant’s SAMG approach as well as strategies to cope with Spent Fuel Pool (SFP) accidents. The plant has started a process of updating its own plant specific SAMG again, based on the updated generic SAMG provided by the PWR Owners Group which now consist of a single set of generic SAMG developed for the three PWR vendor types by incorporating the best features of each of the previous PWR generic SAMG. This third updating process is planned to be completed in 2019. The team recognized this continuous SAMG updating process by the plant as a good performance.

DETAILED ACCIDENT MANAGEMENT FINDINGS

10.1. ORGANIZATION AND FUNCTIONS

10.1(a) Good practice: The plant has developed an overall Emergency Management Guideline (EMG) flowchart, which provides a comprehensive overview of all strategies, guidelines and other relevant documents. This can be used by responsible decision makers for coping with extreme events or extensive damage to plant components

The original Severe Accident Mitigation Guidelines (SAMGs) implemented in the plant in the late nineties provided guidance to operators and Technical Support Centre (TSC) staff to mitigate the consequences of a severe accident beyond the plant's design basis. The Extensive Damage Mitigation Guidelines (EDMGs), being implemented in the plant after the events of 11 September 2001 provide strategies for coping with extreme or extensive damage to plant components. Finally, the approach added after the 2011 Fukushima Daiichi accident by implementing diverse and flexible mitigation strategies, named FLEX, to cope with beyond-design-basis external events. This added an additional layer of protection for the most relevant scenarios: Extended Loss of Alternating Power (ELAP) and Loss of Ultimate Heat Sink (LUHS).

The plant has now developed an overall Emergency Management Guideline (EMG) flowchart, which provides a comprehensive overview of all strategies. It provides guidelines and other relevant documents for coping with extreme events or extensive damage to plant components, to re-establish a command structure, and to perform critical emergency support functions. The structured EMG flowchart allows responsible decision makers (Site Emergency Director or Senior Operations on Shift or other Senior Operations Personnel) to take the right decisions under various plant conditions that do not allow for more detailed planning in advance. This structured EMG flow chart has been presented and discussed within PWROG recently and implementation by the other plants of the PWROG is intended.

The team recognized this as a good practice.

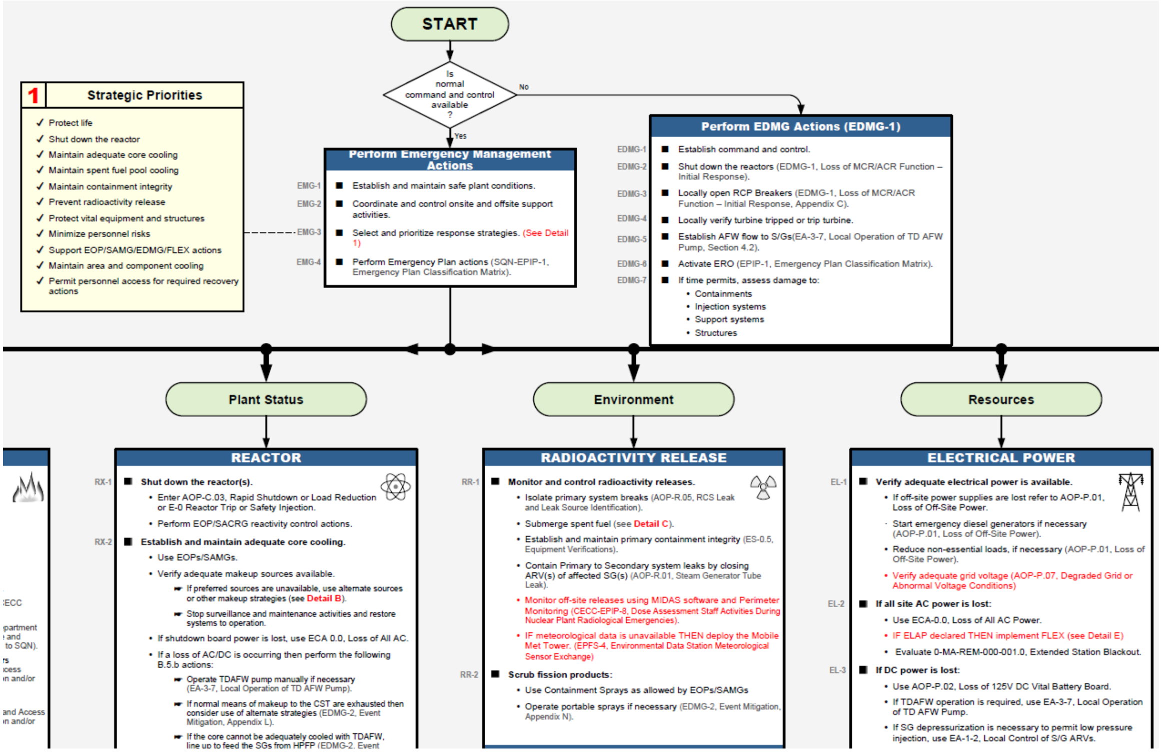

Fig 1. Snapshot of a section of the plant's Emergency Management Guideline (EMG) flowchart

11. HUMAN, TECHNOLOGY, AND ORGANIZATION INTERACTION

11.1 INTERFACES AND RELATIONSHIPS

The plant has fostered a strong relationship with interested members of the public. The Sequoyah Spirit Fund is an employee-created and employee-run non-profit charity designed to give help to families in the area. A part of the proactive outreach to the public is the annual calendars mailed out free of charge every year to residents within the emergency planning zone. The calendars provide additional information, such as siren testing days, nuclear plant operations basics, evacuation routes, important email addresses, phone numbers and emergency supply checklists. Social media channels like Facebook, Twitter and LinkedIn have been frequently used to inform and interact with customers and ‘media days’ are arranged every year. Plant site tours are offered to the public several times a year. The team recognized this as a good performance.

11.2 HUMAN FACTORS MANAGEMENT

The plant is reducing the overall staff numbers through retirement programmes and voluntary terminations, and filling current open positions within some understaffed departments at the same time. Despite the ongoing recruitment to understaffed departments, the team noted a concern among employees regarding the current and future workload, work-related stress and the loss of competences and knowledge in some departments. This concern was also identified in several Condition Reports (CRs) and the quarterly safety culture assessments. The team encouraged the plant to carefully assess this concern of the employees and address its potential effect.

11.4 SAFETY CULTURE

The procedure for nuclear safety culture self-assessments does not include a sufficiently diverse range of tools necessary to gather all the information required for effective analysis. The previous periodic safety culture self-assessment results were based on surveys but other tools, such as interviews, focus groups and observations, were only used if the survey revealed any gaps. The periodic safety culture self-assessment reports reviewed by the team did not contain any information on the effectiveness of the corrective actions related to the identified issues from previous assessments. The team made a suggestion in this area.

DETAILED HUMAN TECHNOLOGY AND ORGANIZATION INTERACTION

11.4 SAFETY CULTURE

11.4(1) Issue: The procedure for nuclear safety culture self-assessments does not include a sufficiently diverse range of tools necessary to gather all the information required for effective analysis.

Periodic nuclear safety culture self-assessments are conducted at the plant every two years. However, the team noted the following:

- The procedure on Conduct of Nuclear Safety Culture Assessments and Organizational Effectiveness Surveys does not contain clear requirements on the use of multiple methods to conduct safety culture assessments.
- The procedure on Conduct of Nuclear Safety Culture Assessments and Organizational Effectiveness Surveys does not contain requirements for corrective action effectiveness evaluations on a regular basis.
- The periodic safety culture self-assessment results are based on surveys. Other tools, such as interviews, focus groups and observations, are only used if the survey reveals any gaps.
- The reviewed periodic safety culture self-assessment reports did not contain any information on the effectiveness of the corrective actions related to the identified issues from previous assessments.
- The latest safety culture assessment conducted in 2015 focused more on programme execution than on nuclear safety culture.

Without the use of broad and diverse sources of information during the safety culture periodic self-assessments, and without evaluating the effectiveness of the corrective actions, the plant may miss the opportunity to detect and identify safety culture related issues.

Suggestion: The plant should consider improving the periodic safety culture self-assessment procedure to ensure a diverse range of tools are used during self-assessments.

IAEA Bases:

GSR Part 2
Chapter 6, Requirement 14 - Measurement, assessment and improvement of leadership for safety and of safety culture

Senior management shall regularly commission assessments of leadership for safety and of safety culture in its own organization.

6.9. Senior management shall ensure that self-assessment of leadership for safety and of safety culture includes assessment at all organizational levels and for all functions in the organization. Senior management shall ensure that such self-assessment makes use of recognized experts in the assessment of leadership and of safety culture.

6.10. Senior management shall ensure that an independent assessment of leadership for safety and of safety culture is conducted for enhancement of the organizational culture for safety (i.e. the organizational culture as it relates to safety and as it fosters a strong safety culture in the organization).

6.11. The results of self-assessments and independent assessments of leadership for safety and of safety culture shall be communicated at all levels in the organization. The results of such assessments shall be acted upon to foster and sustain a strong safety culture, to improve leadership for safety and to foster a learning attitude within the organization.

GS-G-3.5

Chapter 6 - Measurement, assessment and improvement, Assessment of Safety culture

6.35, The self-assessment of safety culture should include the entire organization. Several different self-assessment tools should be used to determine the status of the safety culture of the organization…

6.37, The self-assessment team should summarize the results and identify areas for improvement and may suggest actions to be taken. The results should be reported to the management at an appropriate level; one that is responsible for the implementation of improvement actions. A follow-up assessment should be performed, account being taken of the time needed for improvement actions to have their full effect on the safety culture.

12. LONG TERM OPERATION

12.1. ORGANIZATION AND FUNCTIONS

The Ageing Management Coordinator role is used effectively at the plant to integrate various aspects of Ageing Management programmes across all of the Programme Owners and Engineering Management team as well as providing an essential interface with other plant organizations. A primary focus of the coordinator is to ensure plant and industry operation experience is evaluated for impacts to plant programmes. The team recognized the effective utilization of the Ageing Management Coordinator role as a good performance.

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

No Ageing Management Review (AMR) on 'uninsulated ground conductors' commodity group was performed as part of the License Renewal (LR) evaluation. The grounding system and lightning protection system is to be included in the 'uninsulated ground conductors' commodity.

These systems have a number of functions; one of them is to create an acceptable and predictable Electromagnetic/Radio-Frequency Interference environment for safety related components. The plant is encouraged to perform an AMR on the uninsulated ground conductors including lightning protection system.

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

Currently reviews use calculated operational temperature and radiation dose as a basis for qualified life time calculations. No specific measurements of actual environmental conditions were performed as part of LR in order to verify that calculated values are not exceeded on the environmental qualified (EQ) components. The plant is encouraged to perform measurements of actual environmental conditions on the EQ components to verify that environmental values, used when establishing qualified life, are still within calculated values.

The plant is implementing a new ageing management programme, handling Non-EQ Insulated Cables and Connections. The programme will visually inspect accessible cables in adverse localized locations. The visual inspection is intended to detect surface anomalies which are indications of ageing effects. The amount of visually inspectable cables is limited because:

- The vast majority of cables are routed inside conduit or covered with fire protection paint.
- Cables and connections that require ladders or scaffolding to be visually accessible are not required for this inspection.

The plant is encouraged to evaluate the use of additional methods along with visual inspection to verify the status of Non-EQ cables.

The plant is implementing a new ageing management programme handling Non-EQ Cable Connections. The scope of connections does not include 161kV oil filled cable connections. The team encouraged the plant to include the 161kV oil filled cable connections in the Non-EQ Cable Connections programme.

DETAILED LONG TERM OPERATION FINDINGS

None

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:

- It is novel;
- It has a proven benefit;
- It is replicable (it can be used at other plants);
- It 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 of note. 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 1** Governmental, Legal and Regulatory Framework for Safety (General Safety Requirements)
- **GSR Part 2;** Leadership and Management for Safety (General Safety Requirements)
- **GSR Part 3;** Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, Interim Edition
- **GSR Part 4**; Safety Assessment for Facilities and Activities (General Safety Requirements 2009)
- **GSR Part 5**; Predisposal Management of Radioactive Waste (General Safety Requirements)
- **GSR Part 7;** Preparedness and Response for a Nuclear or Radiological Emergency (General Safety Requirements)
- **SSR-2/1 Rev.1**; Safety of Nuclear Power Plants: Design (Specific Safety Requirements)
- **SSR-2/2 Rev.1**; Safety of Nuclear Power Plants: Operation and Commissioning (Specific Safety Requirements)
- **NS-G-1.1**; Software for Computer Based Systems Important to Safety in Nuclear Power Plants (Safety Guide)
- **NS-G-2.1**; Fire Safety in the Operation of Nuclear Power Plans (Safety Guide)
- **NS-G-2.2**; Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants (Safety Guide)
- **NS-G-2.3**; Modifications to Nuclear Power Plants (Safety Guide)
- **NS-G-2.4**; The Operating Organization for Nuclear Power Plants (Safety Guide)
- **NS-G-2.5**; Core Management and Fuel Handling for Nuclear Power Plants (Safety Guide)
- **NS-G-2.6**; Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants (Safety Guide)
- **NS-G-2.7**; Radiation Protection and Radioactive Waste Management in the Operation of Nuclear Power Plants (Safety Guide)
- **NS-G-2.8**; Recruitment, Qualification and Training of Personnel for Nuclear Power Plants (Safety Guide)
- **NS-G-2.9**; Commissioning for Nuclear Power Plants (Safety Guide)
- **NS-G-2.11**; A System for the Feedback of Experience from Events in Nuclear Installations (Safety Guide**)**
- **NS-G-2.12**; Ageing Management for Nuclear Power Plants (Safety Guide)

- **NS-G-2.13**; Evaluation of Seismic Safety for Existing Nuclear Installations (Safety Guide)
- **NS-G-2.14;** Conduct of Operations at Nuclear Power Plants (Safety Guide)
- **NS-G-2.15**; Severe Accident Management Programmes for Nuclear Power Plants Safety Guide (Safety Guide)
- **SSG-13**; Chemistry Programme for Water Cooled Nuclear Power Plants (Specific Safety Guide)
- **SSG-25**; Periodic Safety Review for Nuclear Power Plants (Specific Safety Guide)
- **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-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
- **GS-G-3.1**; Application of the Management System for Facilities and Activities (Safety Guide)
- **GS-G-3.5**; The Management System for Nuclear Installations (Safety Guide)
- **RS-G-1.1**; Occupational Radiation Protection (Safety Guide)
- **RS-G-1.2**; Assessment of Occupational Exposure Due to Intakes of Radio-nuclides (Safety Guide)
- **RS-G-1.3**; Assessment of Occupational Exposure Due to External Sources of Radiation (Safety Guide)
- **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)

INSAG, Safety Report Series

- **INSAG-4**; Safety Culture
- **INSAG-10**; Defence in Depth in Nuclear Safety

- **INSAG-12**; Basic Safety Principles for Nuclear Power Plants, 75-INSAG-3 Rev.1
- **INSAG-13**; Management of Operational Safety in Nuclear Power Plants
- **INSAG-14**; Safe Management of the Operating Lifetimes of Nuclear Power Plants
- **INSAG-15**; Key Practical Issues In Strengthening Safety Culture
- **INSAG-16**; Maintaining Knowledge, Training and Infrastructure for Research and Development in Nuclear Safety
- **INSAG-17**; Independence in Regulatory Decision Making
- **INSAG-18**; Managing Change in the Nuclear Industry: The Effects on Safety
- **INSAG-19**; Maintaining the Design Integrity of Nuclear Installations Throughout Their Operating Life
- **INSAG-20**; Stakeholder Involvement in Nuclear Issues
- **INSAG-23**; Improving the International System for Operating Experience Feedback
- **INSAG-25**; A Framework for an Integrated Risk Informed Decision Making Process
- **Safety Report Series No.11**; Developing Safety Culture in Nuclear Activities Practical Suggestions to Assist Progress
- **Safety Report Series No.21**; Optimization of Radiation Protection in the Control of Occupational Exposure
- **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
- **EPR-NPP Public Protective Actions - 2013**- Actions to protect the public in an Emergency due to Severe Conditions at a Light Water Reactor

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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