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REPORT

OF THE

PRE-OPERATIONAL SAFETY REVIEW TEAM

(PRE-OSART)

MISSION

TO

UNIT 3

OF THE

MOCHOVCE NUCLEAR POWER PLANT

SLOVAK REPUBLIC

18 NOVEMBER TO 5 DECEMBER 2019

DIVISION OF NUCLEAR INSTALLATION SAFETY
OPERATIONAL SAFETY REVIEW MISSION
IAEA-NSNI/OSART/209/2019

PREAMBLE

This report presents the results of the IAEA Pre-Operational Safety Review Team (Pre-OSART) review of Unit 3 of Mochovce Nuclear Power Plant, Slovak Republic. It includes recommendations for improvements affecting operational safety for consideration by the responsible Slovakian 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 Slovak Republic organizations is solely their responsibility.

FOREWORD

by the Director General

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

An OSART mission, carried out only at the request of the relevant Member State, is directed towards a review of items essential to operational safety. The mission can be tailored to the particular needs of a plant. A full scope review would cover eleven operational 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, and human, technology and organization interactions. 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 IAEA Safety Standards 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 Pre-Operational Safety Review Team (Pre-OSART) mission conducted at Unit 3 of Mochovce Nuclear Power Plant in the Slovak Republic from 18 November to 5 December 2019.

The purpose of a Pre-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 Pre-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 Commissioning.

The mission was coordinated by an IAEA Team Leader and Deputy Team Leader and the team was composed of experts from Brazil, Canada, China, Czech Republic, Finland, France, Germany, Hungary, Romania, Russian Federation, and UK, together with the IAEA staff members and observers from Austria, Italy, and Russian Federation. The collective nuclear power experience of the team was approximately 350 years.

The team identified 22 issues, resulting in 14 recommendations, and 8 suggestions. One good practice was also identified.

Several areas of good performance were noted:

- The plant has implemented the automatic actuation of low-pressure safety injection into the reactor should the water level fall below a set value during shutdown states to improve safety.
- The plant has developed and demonstrated a plant online crisis staff decision support tool to support event classification and prognosis in case of emergencies.
- The plant has adopted an effective way of interfacing and communicating with external organizations and interested parties, in particular with youth, to improve the awareness of nuclear power.

The most significant issues identified were:

- The plant has not fully developed and implemented an integrated and strategic approach to support the safe commissioning of the plant.
- High standards and expectations are not always set or applied with rigour to ensure safe operation.
- Unsafe behaviours and conditions in the plant are not always challenged and corrected by managers and supervisors in a timely manner to ensure safety of personnel and equipment.

Mochovce 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 Slovak Republic, an IAEA Pre-Operational Safety Review Team (Pre-OSART) of international experts visited Unit 3 of Mochovce Nuclear Power Plant from 18 November to 5 December 2019. 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 Commissioning. 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 Mochovce 3 OSART mission was the 209 in the programme, which began in 1982. The team was composed of experts from Brazil, Canada, China, Czech Republic, Finland, France, Germany, Hungary, Romania, Russia Federation, and UK, together with the IAEA staff members and observers from Austria, Italy, and Russian Federation. The collective nuclear power experience of the team was approximately 350 years.

Before visiting the plant, the team studied information provided by the IAEA and the 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 Pre-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 Pre-OSART team were based on the plant's performance compared with good international practices.

The following report is produced to summarize the findings in the review scope, according to the OSART Guidelines document. In cases where common facilities, processes and staff are shared between Unit 3 and Unit 1 and 2 of Mochovce NPP, facts of relevant aspects of Unit 1 and 2 are included. 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 Pre-OSART team concluded that the managers of Unit 3 of Mochovce NPP are committed to improving the operational safety and reliability of their plant. The team found areas of good performance, including the following:

- The plant has implemented the automatic actuation of low-pressure safety injection into the reactor should the water level fall to below a set level during shutdown states to improve safety.
- The plant has developed and demonstrated a plant online crisis staff decision support tool to support event classification and prognosis in case of emergencies.

- The plant adopted an effective way of interfacing and communicating with external organizations and interested parties, in particular with young people, to improve the awareness of nuclear power.

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

- The plant has not fully developed and implemented an integrated and strategic approach to support the safe commissioning of the plant.
- High standards and expectations are not always set or applied with rigour to ensure safe operation.
- Unsafe behaviours and conditions in the plant are not always challenged and corrected by managers and supervisors in a timely manner to ensure safety of personnel and equipment.

Mochovce 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 had established a set of expectations including Safety and Environment; Teamwork; Responsibility; and Knowledge and Experience. However, the team noted that unsafe behaviours and conditions in the plant were not always challenged and corrected by managers and supervisors in a timely manner to ensure the safety of personnel and equipment. The team noted the lack of challenge and correction by managers and supervisors during activities where the requirement to have an oxygen meter was displayed but one was not used; welding and grinding conducted without appropriate controls in place; and work activities performed without the required personal protective equipment. The team also noted that managers had not successfully challenged and corrected performance gaps in the area of radiation protection as, over the past twelve months, there had been five related radiography events. The team made a recommendation in this area.

The plant had included more than 200 design changes from the Unit 1 and 2 design into the design of Unit 3 with a goal to improve safety. The Probabilistic Safety Analysis (PSA) results for Core Damage Frequency (CDF) for unit 3 showed an improvement factor of two from Unit 1 and 2. Once these changes have been fully implemented, this would represent a safety improvement of the Unit 3 design over the unit 1 and 2 plant design. The team recognized this as good performance.

1.3. NON-RADIATION-RELATED SAFETY PROGRAMME

The Industrial Safety programme was not strictly implemented to prevent injury to plant personnel. The team noted unsafe conditions in the plant including improper storage of compressed gas cylinders; unprotected openings exposing fall hazards; workers driving without using seatbelts; and work activities conducted without adequate control of work areas. In addition, the team noted that the plant performance indicators showed declining performance between 2017 and October 2019 in industrial safety events. The team made a recommendation in this area.

DETAILED LEADERSHIP AND MANAGEMENT FOR SAFETY

1.1. LEADERSHIP FOR SAFETY

1.1(1) Issue: Unsafe behaviours and conditions in the plant are not always challenged and corrected by managers and supervisors in a timely manner to ensure safety of personnel and equipment.

The team noted the following:

- Two workers were working in an area in which the use of an oxygen meter was required but no oxygen meter was being used. The signage at the entry to the area as well as the safety information in the daily briefing package clearly identified the requirement to use an oxygen meter in these areas. A manager stated that having every work group bring in their own oxygen meter was impractical based on the number of workers accessing this area. A manager indicated that the posted requirements could be exempted based on regular oxygen level checks and system pressure monitoring performed by operators, however the posted requirements had not been changed.
- Outside the Diesel Generator (DG) Building for Units 3 and 4, there was welding work on a platform without protection to prevent sparks spreading to surrounding areas. There was a ventilation duct located underneath the platform. Close by, on a separate platform, grinding work was being conducted without fire resistant protection to prevent sparks from spreading. This area also had a ventilation duct underneath. Both locations were adjacent to high traffic areas yet no intervention to the conditions occurred.
- Five instances of workers performing painting or cleaning of painting equipment with volatile solvents with no respiratory protection for prolonged (all day) exposure to these fumes. Three of these workers were working in high traffic areas yet no intervention regarding the conditions occurred.
- In the Essential Service Water Supply Building, there was a vertical ladder to the access platform for pump 8PEA33AP001 without a chain, bar or gate at the platform at the top of the ladder. In the turbine building multiple access platforms do not have chains, bars or gates installed at the top of their access ladders. This resulted in an increased risk of workers on the platforms being exposed to a fall hazard of greater than 1.5 metres. No action to address this situation had been taken by the plant.
- A worker on a scaffold in the Administration Building was repairing an overhead light fixture without a helmet, safety glasses or gloves. The work area was not marked and was in a high traffic area. After prompting, the worker was challenged by a manager but was not receptive to the coaching. A few minutes later, a similar situation was observed at another light fixture with another worker.
- During a walk-through Unit 3, a manager stopped frequently to ask workers to put on their safety glasses. About 25% of the workers were not wearing their safety glasses.
- From an observation of five people using the stairs in the administration building, none were holding the handrail and two of them were walking down the stairs while talking on their cell phones. No coaching of this behaviour occurred by managers present in these cases.
- Several scaffolds were found not checked on a weekly basis as required by plant expectations. These scaffolds were last checked 4 November 2019 with the next

inspection due on 11 November 2019 but had not been checked as of 19 November 2019. Examples included the scaffold next to 3JNF60CL002 in Room A003/1 and the scaffold next to 3JNG61P001.

- Damaged cladding over insulation on pipework was evident throughout the nuclear island of Unit 3. Examples include safety systems in room A0017 as well as in Steam Generator rooms A211/1. This damage appeared to be caused by personnel standing on the cladding. Managers were aware of this deviation from expected performance.
- During Manager in the Field walk downs gaps in adherence to expectations were observed. In some of these cases, there was no coaching by peers or managers on the behaviours that did not meet expectations. The deviations included fire doors blocked open or left open, safety glasses not being worn, and material left on stairs or stored inappropriately. A manager indicated that strategies for correcting behaviours in the field have not been taken in a concerted and comprehensive manner.

Plant Events:

- Repeated unplanned dose rates during radiography on Unit 3:
  - On 3 Nov 2018, unplanned dose rates occurred during radiography.
  - On 7 Mar 2019, unplanned dose rates occurred during radiography.
  - On 9 July 2019, unplanned dose rates occurred during radiography.
  - On 29 August 2019, unplanned dose rates occurred during radiography. This resulted in dose rate alarms in the Unit 2 Main Control Room.
  - On 11 October 2019, unplanned dose rates occurred during radiography.
- There were two repeat events following the actuation of transformer fire suppression system in which personnel proceeded without certainty which management challenge and intervention was not able to prevent after a similar event occurred.

Unless unsafe behaviours and conditions are challenged and corrected in a timely manner, the risk of injury to personnel and equipment damage will increase.

Recommendation: The plant should ensure that unsafe behaviours and conditions in the plant are challenged and corrected by managers and supervisors to ensure personnel and plant safety.

IAEA Bases:

GSR Part 2

3.1. The senior management of the organization shall demonstrate leadership for safety by:

(a) Establishing, advocating and adhering to an organizational approach to safety that stipulates that, as an overriding priority, issues relating to protection and safety receive the attention warranted by their significance;

(b) Acknowledging that safety encompasses interactions between people, technology and the organization;

(c) Establishing behavioural expectations and fostering a strong safety culture;

(d) Establishing the acceptance of personal accountability in relation to safety on the part of all individuals in the organization and establishing that decisions taken at all levels take account of the priorities and accountabilities for safety.

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.

4.25. Senior management shall ensure that individuals at all levels, including managers and workers:

(a) Are competent to perform their assigned tasks and to work safely and effectively;
(b) Understand the standards that they are expected to apply in completing their tasks.

SSR-2/2(Rev.1)

3.2. Managers at all levels in the organization, taking into account their duties, shall ensure that their leadership includes:

(a) Setting goals for safety that are consistent with the organization's policy for safety, actively seeking information on safety performance within their area of responsibility and demonstrating commitment to improving safety performance;
(b) Development of individual and institutional values and expectations for safety throughout the organization by means of their decisions, statements and actions;
(c) Ensuring that their actions serve to encourage the reporting of safety related problems, to develop questioning and learning attitudes, and to correct acts or conditions that are adverse to safety.

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;
(b) Shall engage all individuals in enhancing safety performance;

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.

NS-G-2.4

3.6. The operating organization should establish high performance standards for all activities relating to safe operation of a plant, and should effectively communicate these standards throughout the organization. All levels of management should promote and require consistent adherence to these high standards. Management of the operating organization should foster a working environment that encourages the achievement of high standards in safe operation of the plant.

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 PROGRAMME

1.3(1) Issue: The Industrial Safety programme is not strictly implemented to prevent injury to plant personnel.

The team noted the following:

- Two unsecured compressed gas cylinders were in the storage cage under cable tray 3AN8463.01T, furthermore this storage cage contained other Hydrogen compressed gas cylinders for the generator.
- One contract scaffolder worker was observed working at a height of about 2.5 metres on a scaffolding post in the turbine building without a safety harness attached to an anchor point.
- While driving to a worksite, a person was driving without properly fastening their seatbelt. The seatbelt was found to be strapped behind the seat in order to defeat the alarm. This was against plant expectations.
- A scaffold was being dismantled within a busy pedestrian thoroughfare on Unit 3 without any work area barriers in place. The workers left the work area, leaving scaffold material in the walkway. Additionally, a multiple-level scaffold was also being dismantled without a work area barrier on the level below the work, allowing a group to enter the work area at the same time as materials were being lowered to the ground floor.
- Three workers were observed going down stairs in the turbine building carrying equipment and not holding the handrail. One of the workers was carrying a ladder about 2.5 metres long, the others were carrying pails and tools.
- On the Unit 3 A525 platform in the reactor hall, some materials were stored very close to the edge of the platform with the potential to fall through an opening to the floor beneath.
- An emergency eyewash cabinet beside panel 3BTM61 near battery rooms contained debris on the eyewash bottles and inside the cabinet, which had the potential to enter the eyes if the eye wash was used.
- An 50cm by 50cm opening in the flooring close to Generator 2 was not covered exposing a fall hazard of several metres to the level below.
- In room 6368, there were 10 iron rods (approximately 3 cm diameter, 10 cm high) emerging from the floor without protection. The hazard information to warn people not to enter the area was hidden by an open fire door.
- When repositioning improperly stored steel plates, stores staff repositioned the steel plates without using protective gloves.

Plant Industrial Safety Performance trends:

- The Unit 3/4 Industrial Safety Performance showed a decline in performance from 2017 to October 2019. From the plant safety performance statistics:
  - The number of Lost Time Incidents increased from 0 in 2017 to 1 in 2018 and 3 in 2019 up to October
  - The number of First Aid cases increased from 9 in 2017 to 16 in 2018 and 11 in 2019 up to October.

- The number of Near Miss cases increased from 33 in 2017 to 44 in 2018 and 27 in 2019 up to October.

Lack of strict implementation of the industrial safety programme could result in injury to plant personnel.

Recommendation: The plant should improve the implementation of the industrial safety programme.

IAEA Bases:

GSR Part 2

4.25. Senior management shall ensure that individuals at all levels, including managers and workers:
(a) Are competent to perform their assigned tasks and to work safely and effectively;
(b) Understand the standards that they are expected to apply in completing their tasks.

SSR-2/2 (Rev. 1)

5.26 The non-radiation-related safety programme 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 programme. 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.

NS-G-2.4

3.6. The operating organization should establish high performance standards for all activities relating to safe operation of a plant, and should effectively communicate these standards throughout the organization. All levels of management should promote and require consistent adherence to these high standards. Management of the operating organization should foster a working environment that encourages the achievement of high standards in safe operation of the plant.

NS-G-2.14

2.19. The operations managers and supervisors should, through consistent words and actions, develop a working environment that fosters adherence to the operating policy and reflects high standards of performance. The need for conservative decision making, a questioning attitude and thoroughness in carrying out plant operating activities should be reinforced.

GS-G-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

2.2. QUALIFICATION AND TRAINING OF PERSONNEL

The team observed that Main Control Room (MCR) operator training, field operator on the job training (OJT) and associated performance evaluations were insufficient to ensure operations personnel performance. MCR operators received initial and refresh simulator training using Unit 3 simulator with some major differences compared with the reference Unit. The plant had not finished the implementation of the systematic approach to training (SAT) for operator training in Unit 3. Field operator OJT training requirements did not include a formal task performance evaluation. The team made a recommendation in this area.

DETAILED TRAINING AND QUALIFICATION FINDINGS

2.2. QUALIFICATION AND TRAINING OF PERSONNEL

2.2(1) Issue: Main Control Room (MCR) operator training, field operator on the job training (OJT) and associated performance evaluations are insufficient to ensure operations personnel performance.

The team noted the following:

- The shift crews received initial and refresher simulator training using Unit 3 simulator with some major differences compared with reference Unit. There was a total of 327 differences, of which 35 were on safety systems.
- The simulator has not been available since April 2019 and was scheduled to be available after the update in February 2020. The plant conducted just two days of Severe Accident Management (SAM) and one day of fire protection classroom training to substitute for the lack of simulator availability, and there were no additional compensatory measures in place to train the shift crews before the planned initial fuel load.
- The plant had not finished the implementation of systemic approach to training (SAT) for operations personnel training in unit 3.
- Two out of six Unit 3 and 4 shift supervisors had not participated in the required theoretical continuing training for the past 3-year cycle.
- Field operators received five days OJT when they transferred from Units 1 and 2 to Units 3 and 4. However, the OJT training requirements for nuclear field operator only include very brief description, and no formal task performance evaluation was carried out after OJT, only an oral examination by expert panel was conducted.
- MCR Back-Up Panel (BUP) and Emergency Control Room (ECR) related scenarios were not included in Unit 3 and 4 initial simulator training but were included in continuing simulator learning scenarios in 2015 and 2016. Because the plant transferred operators from Units 1 and 2 to Units 3 and 4 in different years, some MCR operators did not receive these related training on these learning scenarios. There were no compensatory measures to ensure that all the operators received simulator training in these areas before the planned initial fuel load.
- Some operators from Unit 3 were assigned to receive more than one year On-Duty training in Units 1 and 2 after their advancement to Reactor Operator, Unit Supervisor or Shift Supervisor position. However, they did not receive compensatory continuing training after they returned to Unit 3 when they had been away from their authorized duties for an extended period.
- No formal evaluations were conducted after annual shift training days which are part of operator continuing training.

Without enough adequate MCR operator training, field operator on the job training and performance evaluation, the operations personnel performance will be adversely impacted.

Recommendation: The plant should improve the Main Control Room operator training, field operator on the job training and performance evaluation, to ensure satisfactory performance of operations personnel.

IAEA Bases:

SSR-2/2 (Rev.1)
4.20. Performance based programmes for initial and continuing training shall be developed and put in place for each major group of personnel (including, if necessary, external support organizations, including contractors). The content of each programme shall be based on a systematic approach. Training programmes shall promote attitudes that help to ensure that safety issues receive the attention that they warrant.

NS-G-2.8
4.13. A systematic approach to training should be used for the training of plant personnel (see Ref. [5]). The systematic approach provides a logical progression, from identification of the competences required for performing a job, to the development and implementation of training towards achieving these competences, and to the subsequent evaluation of this training. The use of a systematic approach to training offers significant advantages over more conventional, curricula driven training in terms of consistency, efficiency and management control, leading to greater reliability of training results and enhanced safety and efficiency of the plant [6].
4.15. The following training settings and methods, which are widely used and have proved to be effective in attaining the training objectives when appropriately chosen, should be considered:
(b) On the job training should be conducted in accordance with prescribed guidelines provided by incumbent staff who have been trained to deliver this form of training. Progress should be monitored and assessments should be carried out by an independent assessor.
(c) Initial and continuing simulator based training for the control room shift team should be conducted on a simulator that represents the control room. The simulator should be equipped with software of sufficient scope to cover normal operation, anticipated operational occurrences and a range of accident conditions. Other personnel may also benefit from simulator based training.
4.19. Training at a plant reference, full scope simulator facility should be provided for control room operators whose actions have an immediate influence on plant behaviour. Trainees should also be confronted with infrequent and abnormal situations which have a low probability of occurrence and therefore cannot be enacted in real plant practice. Consideration should be given to training control room staff as a team to develop team skills, good communication and co-ordination habits and trust in the application of plant procedures.
5.2. Training programmes for most positions at a nuclear power plant should include on the job training, to ensure that trainees obtain the necessary job related knowledge and skills in their actual working environment. Formal on the job training provides hands-on experience and allows the trainee to become familiar with plant routines. However, on the job training does not simply mean working in a job and/or position under the supervision of a qualified individual; it also involves the use of training objectives, qualification guidelines and trainee assessment. This training should be conducted and evaluated in the working environment by qualified, designated individuals.

3. OPERATIONS

3.2. OPERATIONS EQUIPMENT

The team noted that the radio communication system did not function in all areas of the plant. This had contributed to an event. The team encouraged the plant to ensure all communication systems are fully functional in all technical areas.

3.4. CONDUCT OF OPERATIONS

The team identified that high standards and expectations were not always set or applied with rigour to ensure safe operation. Identified areas included the insufficient management of important keys in the Main Control Room (MCR), inconsistent use of the risk assessment and decision making process, field operators not consistently checking areas handed over and not identifying issues in the field. Error reduction tools such as self-check and safe communication were not consistently used and this had led to events, and the basic MCR access rules were not always respected or reinforced. The team made a recommendation in this area.

The team noted that some of the plant operating procedures and supporting documentation were not always complete and used rigorously to support safe operation. Clear guidance was missing on which systems would be affected in case of fire in specific rooms, procedures were not always referred to by operations staff, and operations in the electrical cabinets or switchyard were conducted with limited procedural guidance which led to the interruption of electrical supply to the neighbouring unit and the unavailability of the MCR for a short time. The team made a recommendation in this area.

The team observed that important plant parameters and equipment conditions were not always precisely monitored by Main Control Room personnel to ensure equipment and plant safety. Plant status was not always verified using all available sources of information during shift turnovers, monitoring requirements were not precisely defined and switchover activities were not sufficiently prepared and monitored after execution. The team made a suggestion in this area.

A robust surveillance test process had not yet been introduced on Unit 3 . A recent example was the incomplete routine test of the main transformer fire suppression system. The team encouraged the plant to ensure that all aspects of surveillance test requirements were completed and integrated into the test process before first fuel loading.

The team observed that equipment codes were not directly visible on the Human Machine Interface (HMI) computer displays in the main control room. This could delay the required actions by operators in normal and accident conditions. The team encouraged the plant to continue its efforts to make equipment identification visible directly on displays.

3.5. WORK CONTROL

The team observed that the plant practices for tagging and isolation of equipment were not properly controlled to ensure safety of personnel and equipment. There were no clear requirements describing under what circumstances valves or electric cubicles should be locked. Some valves were found incorrectly tagged and electrical and mechanical equipment that should have been locked were not. In addition, suitable locking devices were not always available. The team made a recommendation in this area.

3.6. FIRE PREVENTION AND PROTECTION PROGRAMME

The team observed that the plant's fire prevention and fire suppression arrangements were not fully developed and implemented to ensure that fire risk was minimized. Grinding and welding works were conducted without a fire watch and were not properly protected to prevent the spreading of sparks to adjacent equipment and flammable material. In addition, a previous fire had occurred in the reactor vessel under similar circumstances. Deviations were observed in fire barriers, additional fire loads and portable extinguishing systems. These deviations were not known by the fire brigade. The team made a recommendation in this area.

DETAILED OPERATIONS FINDINGS

3.4. CONDUCT OF OPERATIONS

3.4(1) Issue: High standards and expectations are not always set or applied with rigour to ensure safe operation.

The team noted the following:

- Key management:
  - The key to open the fire cabinet adjacent to the Main Control Room (MCR) was not included in the key cabinet containing keys important for safety. In addition, the fire computer software interface was not available which could cause additional delays in identification of fire alarms.
  - A check of the key cabinet containing keys important to safety revealed that the key to allow the operation of a safety valve on a control panel in the MCR was not in its dedicated position, and there was a delay in locating the key.
  - A check of the key cabinet containing keys important to safety in the Unit 3 MCR revealed that there were more keys in the cabinet than on the inventory list, for example on positions38 and 43 to 49 there were keys hanging. Furthermore, the list contained handwritten additions and keys had been added at other key locations.
- Risk assessment and Decision Making:
  - The investigation conducted after an unplanned power loss in the 6kV distribution system revealed that the human factors risks of communication errors between field and MCR during the remote switching of circuit breakers was not sufficiently considered and addressed.
  - During the observation of simulator refresher training in Units 1 and 2 it was observed that the decision-making process and setting of the response strategy did not always involve all crew members. For example, when facing a loss of intermediate cooling water circuit, the Unit supervisor decided to shut down the main circulation pumps in a certain sequence. Two minutes later he changed the strategy and opted for an anticipated manual reactor trip (SCRAM) in order to avoid overheating of main circulation pumps. This decision was taken within a short time and without involving or updating the crew. These aspects were not covered during the debriefing session. In addition, team briefs were not used to update the crew on the current plant status.
  - Even though, the plant had a procedure describing the decision-making process, it did not contain easy to use tools to help the shift crews, in unexpected situations, perform a risk analysis and make appropriate operational decisions.
- Field monitoring and observation:
  - During an operator round in the Nuclear Island, it was observed that components and systems which were already turned over to Operations, for example, most valves of the Leak Collection System, were not included in the list required to be checked.
  - Deviations on equipment under commissioning were not systematically recorded. In addition, there was no way to differentiate in the field if equipment was under commissioning or turned over to Technical Operation.

  - In a monitoring sheet for firefighting systems 8ZP it was not required that the field operator filled in the exact value, but only to check if the value was inside the range, furthermore the operator filled ‘OK’ although 3SGD92CP101 was outside the expected range.
  - During field rounds in the ventilation building and Turbine Hall, deviations such as flammable products stored without proper monitoring, fire loads without identification, opened or damaged fire doors, housekeeping deviations and a non-covered opened circuit on compressed air system were not noted by field operators.
  - Uncontrolled temporary pen markings highlighting the maximum allowable value were found on pressure indicators related to safety class 3 systems on multiple occasions (for example, leak collection),
  - Labelling of Structures, Systems and Components inside the Diesel Generator 1 building were not consistent: some were redundant, some were hand written, others were duplicated (hand written and stamped). For example, the electrical motor 3XJG01AP002-M1 had on the motor cover the following label: 3XJG-1AP2 which was incorrect.
- Use of Error reduction tools:
  - The event investigation conducted after an unplanned power loss in the 6kV distribution system identified that although some informal pre-job briefing had been conducted with the staff involved this was not based on a formal checklist.
  - During training simulator observation, operators did not use any procedure during the scenario but followed orders from unit supervisor who was using the required procedure. As a consequence, it was not possible to implement self-check. In addition, formal communications were not consistently used between unit supervisors and operators
  - The team observed that, during a weekly surveillance test on the transformer fixed firefighting extinguishing equipment logic check, a technician did not ensure he was on the correct cabinet, as he did not self-check the plant identification code written in the procedure with the actual one on the cabinet. Furthermore, the procedure prescribes ‘continuous use’, but the procedure was not opened and referred to during the test.
  - During a weekly surveillance test on the transformer fixed firefighting extinguishing equipment signalisation the pre-job brief (PJB) conducted did not include operating experience from a similar test where, due to miscommunications, the spray system was inadvertently activated.
  - The requirements for the use of human error avoidance tools had not been established for digital computer systems.
- MCR access and serenity:
  - Some basic requirements were set out for the access to the Unit 3 MCR, including the requirement to remove safety helmets. However, this rule was often not respected and some managers were also observed not following this rule. In addition, inappropriate behaviours were not consistently corrected by unit supervisor, shift manager and manager in operations during a 2.5 hours observation period.

- During a 2.5 hours observation period in the Unit 3 MCR serenity was not always maintained. Examples include technical discussions around the reactor operator desk between commissioning personnel and the unit Supervisor, phone calls being conducted and no physical barriers being in place on the reactor operator side.
- About 20 people participated in a PJB inside the MCR for a mobile Diesel Generator test, lasting more than 20 minutes. This created an unnecessary disturbance to the shift crew.
- During the shift turnover briefing a member of the work execution centre entered and exited the MCR, on both occasions the doors were slammed shut, creating unnecessary disturbance.

Without establishing high standards and expectations, or applying these with rigor, the safe operation of the plant could be adversely affected.

Recommendation: The plant should ensure that high standards and expectations in Operations are established and rigorously applied with rigour to ensure safe operation.

IAEA Bases:

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

NS-G-2.14
4.3. The management should ensure that distractions to the shift personnel are minimized to enable the crew to remain alert to any changes in plant conditions. Examples of distractions that should be minimized are excessive administrative burdens and excessive numbers of people allowed entry to the main control room. In particular, the need to minimize such burdens should be taken into account in shift arrangements for accidents and emergencies. This will facilitate maintaining the situational awareness of operators.
4.15. Non-routine operating activities should be prohibited in the main control room during shift turnover. Access of non-shift personnel to the main control room during the shift turnover should be prohibited or minimized
4.29. The management's expectations with regard to performance in the control room should be established and operators should be trained to meet these expectations. These expectations should be made clear and managers should ensure that all operators understand them. Managers should continuously monitor the performance of operators in fulfilling the management's expectations.
4.30. Operations managers should demonstrate and reinforce a conservative attitude to decision making for activities that directly or indirectly affect the reactor core, the integrity of the fuel or the safety systems. Operators should be required to stop and seek advice from the shift supervisor or shift safety engineer when there is uncertainty or lack of clarity. Conservative decision making should be emphasized for instances where conditions outside the normal operating conditions are encountered. Operators should be able to reduce power or to trip the reactor without fear of blame when faced with unexpected or uncertain conditions. Hasty decisions and hurried acts should be avoided. When time does not allow a full understanding

of the conditions to be gained before action, risks should be minimized and the plant should be placed in a 'known safe condition'.

4.31. Operators in the control room should maintain serious and attentive behaviour at all times. Operators should adhere strictly to plant policies with regard to the use of procedures, communication protocols, response to alarms and the use of methods in place to prevent or minimize human error. Operations management and supervisors should make themselves aware of the behaviour of operators in this regard and should ensure that high standards of performance are enforced at all times.

4.34. Rounds should be conducted regularly by the operators to identify actual and potential equipment problems and conditions that could affect the functioning of the equipment. The frequency of equipment inspections should be determined on the basis of the safety significance of the possible failure of the item of equipment, and it should be adjusted when operating conditions or maintenance conditions change. Particular attention should be given to remote areas of the plant and items of equipment that are difficult to access.

4.39. To ensure best practice in identifying and reporting deviations, specific training should be provided to the shift personnel. In addition, supervisors should coach operations crews and individual operators in achieving a consistent standard in identifying and reporting plant deficiencies.

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.

5.6. Specific measures should be developed and maintained to prevent unauthorized access to systems and equipment important to safety. These measures should include controlled access to certain rooms or compartments and an effective key control system or other measures to prevent an unauthorized change in the position of, or an unauthorized intervention affecting, certain important safety valves, transmitters, breakers or other specified equipment. This access control system should not prevent shift operators from effectively controlling the readiness of the safety systems and should allow them to carry out prompt and timely operation of the equipment in normal and abnormal plant conditions.

3.4(2) Issue: Some of the plant operating procedures and supporting documents are not always complete and used rigorously to support safe operation.

The team noted the following:

- On 22 November 2019 an event occurred that resulted in an unplanned power loss and a failure in the 6kV electrical distribution equipment for severe accident management on Units 1 and 2, as a result of a switching issue during a planned alignment on Unit 3. The investigation revealed that no procedure was available for performing the activity, and no Temporary Operating Instruction was issued as a mitigation.
- An event occurred on 5 November 2019 at Unit 3 when, due to planned maintenance activities on inverters, some manipulations on switchboards were performed that caused voltage variations. These resulted in repeated loss of important parameters, both on the Safety Information Computer System (SICS) as well as the Plant Information Computer System (PICS) in the MCR. Furthermore, a trip of operating pumps occurred, AUTO modes were set to MANUAL mode (and vice versa), and there was an inability to operate these pumps from the MCR for a period of around 2 minutes. The preliminary analysis revealed incomplete or unavailable supporting operating procedures as a contributing cause.
- During a weekly surveillance test on the transformer fixed firefighting extinguishing equipment signalisation, a technician did not use and refer to the continuous use procedure.
- During observation of simulator refresher training in Units 1 and 2, it was noted that the operators did not use the prescribed checklists to verify important parameters after a manual SCRAM was initiated.
- In the Unit 3 MCR clear guidance was missing on which systems would be affected should a fire occurs in a specific room. This information was not easy to obtain in case of an electrical cabinet in the switchgear building being affected.
- There was no formal requirement to check the content of the cabinet containing keys important to safety in the Unit 3 MCR, and the inventory list was not controlled.
- There was no formal checklist for the conduct of shift turnovers, (current plant status, availability of safety systems, important standing alarms, work orders, deficiency reports etc.).
- During discussion with a Manager in Operations after observation of simulator refresher training in Units 1 and 2 it was established that the plant had not developed guidance for post-SCRAM checks for Field Operators, for example, on Turbine systems.
- In the process of managing valves with the risk of diluting the primary system there were different checklists in use, one from commissioning and another from operations. The checklists had some overlap and did not use the same abbreviations to check the desired status.
- Management of Temporary Operating Instructions (TOI):
  - 40 TOIs were observed to be stored in 2 different boxes and were not organized appropriately inside these boxes, only 2 were fully signed as acknowledged by the 6 shift crews
  - There was no summary list of applicable TOIs, one TOI related to firefighting was supposed to be in Pumping Station Control room but was actually in the MCR.

- Documentation issues related to weekly monitoring tests:
  - A diesel generator slow rotation test was carried out on 19 August 2019, however, the results were not checked or approved, and the procedure was not fully completed.
  - A monthly check of Fire Fighting equipment for transformers 3BAT01, 3BBT01, 3BAT02, 3BBT02 and 8BCT01 implemented on 15 November 2019 was approved and checked although initial conditions were not appropriately filled in.
  - A test of Firefighting pumps 8SGB01,02,03AP001 contained unsigned handwritten changes.
  - Among monitoring tests in November, only one out of 15 had been checked by operations.
  - In the logbook which registered the tests needed to be reported to the Firefighting authority, the test completed on 16 August 2019 was not documented
- The arrangements for storing operational documents (such as Operating, emergency and accident procedures) at the unit supervisor work station in the MCR did not support easy identification and verification of completeness of documents. The binders were of different sizes, several were not immediately identifiable, as they were hidden between two larger ones. In addition, recently revised procedures were piled up on the bottom of the cabinet in a disorderly manner.
- A folder in the Unit 3 MCR informs the shift crews about revised procedures which should be read and acknowledged by the different members of the shift crew. However, handwritten corrections and additions to the reference sheet as well as signatures not linked to names make it difficult to verify if the required information had been received by the relevant staff.

Unless adequate supporting plant operating procedures and documentation are provided and rigorously used, the probability of errors could increase.

Recommendation: The plant should ensure that adequate supporting plant operating procedures and documentation are provided and used rigorously to support safe operation.

IAEA Bases:

SSR-2/2 (Rev. 1)
7.1. The level of detail for a particular procedure shall be appropriate for the purpose of that procedure. The guidance provided in the procedures shall be clear and concise and, to the extent possible, it shall be verified and validated. The procedures and reference material shall be clearly identified and shall be readily accessible in the control room and in other operating locations if necessary. They shall be made available to the regulatory body, as required. Strict adherence to written operating procedures shall be an essential element of safety policy at the plant.
NS-G-2.14
4.16 All important information about the plant status, the work in progress and the plant evolutions in the previous shift should be transferred and documented properly in the course of the shift turnover. This information should include a joint check of systems in which the incoming and outgoing operators walk down the control panels and jointly read checklists, log books, records and messages to familiarize themselves adequately with the status of systems and equipment.

4.23. Special attention should be paid to ensuring that the procedures are compatible with the environment in which they are to be used. The procedures should be validated in the form in which they will be used in the field. Values prescribed in the procedures should be in the same units as those used on the associated instrumentation in the main control room and in other control rooms and on local control panels or equipment in the plant.
4.26. Administrative controls should be put in place to ensure that the operator prepares carefully for an activity by reviewing the procedure, in order to understand fully the procedural steps to be taken for correct performance of the activity or plant evolution. Special attention should be paid to independent checks and hold points in the procedure at which certain critical tasks are to be performed. When an operator is preparing for an activity, emergency or off-normal procedures should be included in the planning in case conditions outside the normal operating conditions are encountered.
5.5. For each plant system, the valve, switch and breaker alignment should be documented. Prior to the initial operation of a system, a complete alignment check should be carried out. Clear guidance should be established in advance for conditions that may necessitate equipment and system alignment, including conditions in plant start up, major outages and mode changes.
5.19. Departments other than the operations department may be assigned responsibilities by management to develop individual surveillance test procedures, specify the appropriate frequency of testing, complete some of the testing and identify acceptance criteria. The operations department should retain responsibility for the scheduling and accomplishment of tests that involve equipment operation, for the review of completed test reports to ensure the test's completeness and for verification that the test results meet the approved acceptance criteria.

NS-G-2.4
6.26. The operating organization should provide for the development of operating instructions and procedures that:
—ensure that all activities affecting safe operation are covered by appropriate instructions or procedures;
6.32. Shift turnover should be carried out in a structured and professional manner. The effectiveness of shift turnover should be enhanced by a written account of the shift activities. The process of shift turnover should identify the persons involved, their responsibilities, the locations and the conduct of shift turnovers, and the method of reporting plant status, including provisions for special circumstances such as abnormal plant status and staff unavailability.

3.4(3) Issue: Important plant parameters and equipment conditions are not always precisely monitored by Main Control Room personnel to ensure equipment and plant safety.

The team noted the following:

- During a shift turnover the list of standing alarms displayed in the Process Information Computer System (PICS) was not analysed and used as a basis for handover. Although it was explained that currently the system was overloaded with irrelevant alarms, not selecting and analysing relevant alarms could lead to important information not being recognized.
- Operators recorded once per shift a list of parameters which involve Limiting Conditions for operations (LCO). None of the last nine sheets (recording these parameters over a week) were reviewed by the Unit Supervisor (US) or Shift Manager (SM). It was stated that there was no clear expectation on what operators should monitor.
- There was no clear guidance about which parameters should be monitored in the Main Control Room (MCR) and the actions to be taken in case of reaching limiting values were not clearly defined. It was explained that such parameters were part of the initial and refresher training and should be known by operators. However, in the case of a PEC-essential service water system currently in operation it took the operator approximately 10 minutes to find the temperature trip value for the running pump.
- After a routine equipment changeover activity in the Unit 3 MCR, the operator declared (less than five minutes after the start of the pump) that its condition was ‘OK’, even though temperature parameters had not stabilized. Fifteen minutes later, spurious vibration indications occurred, which continued for about an hour.
- When returning to the MCR about an hour after the switchover of 3PEC-Essential Service Water pump there was no operator at the desk and the acting unit supervisor was found to be unaware of vibrations that started approximately one hour before.
- During observation of simulator refresher training in Unit 1 and Unit 2, after loss of the intermediate cooling System, the unit supervisor applying the required procedure asked a field operator to open two intermediate cooling system valves (1KAA10AA008 and 1KAA10AA049). However, it was stated by the Instructor that this was not possible because these valves are pneumatic valves. At the same time the procedure did not require stopping the intermediate cooling pumps which were running without any flow due to the non-opening of these two valves. The pumps running without flow were not detected by the shift team.
- The debriefing session after a simulator refresher training in Unit 1 and Unit 2 was more focussed on technical content rather than on elements of the five Operator Fundamentals, such as teamwork and monitoring. In addition, evaluation criteria in the assessment sheet are currently not linked to the Operator Fundamentals.
- During a routine switchover activity of 3PEC-Essential Service Water pump in Unit 3 MCR the operator did not refer to a procedure or manufacturer data sheet in order to compare the expected plant parameters with the actual ones once the pump was started.
- Currently one of the main tasks of the Turbine Operator in the Unit 3 MCR was to monitor if the level of 3MAV15 lube oil tank on the Turbine Control System was between minimum and maximum, and ensuring the pump started once maximum level was reached. Although no exact value was available and the status only indicated by a colour, flow trending was not used to confirm correct starting of the pump. There was no requirement for displays to be monitored in the MCR nor important parameters to be

monitored periodically; they were only displayed according to Unit Supervisor requirements.

– There was a requirement for the shift manager to perform an independent walk-down of the panels of the MCR once per shift in order to verify actual plant status. However, this was not based on a defined list or table and did not explicitly include the check of the back panel.

Without precisely monitoring the important plant parameters and equipment conditions by Main Control Room operators, the probability of events related to equipment and plant safety could increase.

Suggestion: The plant should consider improving the monitoring of important plant parameters and equipment conditions by Main Control Room personnel to ensure equipment and plant safety.

IAEA Bases:

SSG-28

3.70. From construction to commissioning and finally to operation, the plant should be adequately monitored and maintained. The plant should be subject to the required inspection and periodic testing in order to protect equipment, to support the testing stage and to continue to comply with the safety analysis report and operational limits and conditions. Historical records should be kept of operation and maintenance in the commissioning stage from the time of the initial energization and operation of the equipment of each plant system. Provision should be made to eventually transfer these records to the operating organization.

NS-G-2-14

3.3. Under the authority of the shift supervisor or the unit supervisor, the control room operators6 are responsible for monitoring and control of the plant systems in accordance with the relevant operating instructions and procedures. Field operators are responsible for the control of operational activities outside the control room; such activities should be carried out under the general direction of the control room operators and in accordance with relevant operating instructions and procedures.

3.5. The main responsibilities of the control room operators are to operate the plant and the plant systems in accordance with the design intent and operating procedures and to maintain the reactor and other plant systems within the established operational limits and conditions. The control room operators' activities should cover, but are not limited to, the following items Operation, control and monitoring of plant systems in accordance with relevant operating and administrative procedures;

4.7. While on duty, the shift crew should have as their primary responsibility the monitoring and control of all plant systems and components. On-shift operators should maintain the plant and its supporting systems within the boundaries of equipment alignments that have been analysed as well as within approved procedures and should restrict operations that could lead to a condition outside these boundaries.

4.8. The panels in the control room should be closely monitored. Operators should be required to check important parameters periodically (e.g. hourly), irrespective of whether these parameters are also recorded electronically. An analysis of trends should be carried out if the parameters demonstrate drifting. Supervisors should ensure that other duties (e.g. log keeping) that might distract the operators from the monitoring of panels are limited to short periods of time.

4.9. When a plant manoeuvre is carried out remotely by an operator in the control room, the operator should verify, by checking relevant indicators, that the manoeuvre has indeed been carried out correctly (e.g. if a valve is closed remotely to stop flow, then the operator should check not only that the indicators show the valve position as closed, but also that indicators show that the flow has indeed stopped).

4.33. Operators should be particularly alert to plant indicators and signs of unexpected plant behaviour and should alert shift managers quickly to abnormalities. Operators should perform their activities in a manner that avoids haste. If an operator makes a mistake, he or she should immediately report the error. The supervisor and operator should then proceed carefully to recover the situation. To encourage the reporting of errors, the supervisor should demonstrate a no-blame attitude to errors made by operators.

4.49. The shift crews should routinely monitor the conditions of systems and components and should record appropriately the plant status and parameters and all automatic or manual acts. Every change in the status of systems or components should be appropriately documented and should be communicated to the main control room in a timely manner.

3.5 WORK CONTROL

3.5(1) Issue: The Plant practices for tagging and isolation are not properly controlled to ensure the safety of personnel and plant.

The team noted the following:

- On switchboard cubicle 3JEB16AP0011-M1 related to the Main Coolant Pump System, an easily removable information sheet with 'do not switch ON, work ongoing' was attached. There was no Clearance Tagging Identification on the cubicle and the cubicle was not locked to prevent inadvertent re-energization.
- There was no clear requirement describing under what circumstances valves or switchboard cubicles should be locked.
- Around 10 valves currently in Make-Up Water System (KBA), Low Pressure Safety Injection System (JNG), High Pressure Safety Injection System (JNF), and Boric Acid Concentrate System (KDD) with the potential to affect reactivity control cannot be physically locked, as the plant had not found adequate locking devices. In addition, the electric cubicles which interface with these valves, were not physically locked and some were openly accessible.
- Deviations observed on tagging of equipment:
  - The Clearance Tagging Identification related to the valve 4KDD56AA101 in boric acid system was mistakenly placed on 4KDD56AA201 valve.
  - Only one out of six valves in the condensate system 8KDC was found physically locked as required on a Clearance Tagging Identification. As a result, there was no physical means to prevent any incorrect manipulation of these valves.
  - The Clearance Tagging Identification of valve 8KDC80AA004 was found unattached and laying on valve 8KDC80AA002.This valve was required to be 'locked closed' but there was no locking device..
- It was observed as a common practice in the plant to have re-usable plastic ties, to attach clearance tags to plant equipment. However, these remain on electric cubicles even when the clearance tags were removed. As a result, a large number of these re-usable plastic ties were attached on electric cubicles without clearance tags. As electric cubicles were not locked by Operation, there was an increased risk to inadvertently rack-in electric cubicles in case of a clearance tag on the re-usable plastic ties was removed accidently.
- On firefighting system 3SGD, valve 3SGD92AA004 was locked open without a clearance tag identification. When asked, the operations personnel stated that this was required by procedure and was not put into the tagging software. Just beside this valve, valve 8SCB68AA083 which was in a locked position, was also observed without an identification tag and Operation staff were not able to explain why this valve was locked.
- Different devices , such as locks and chains, for blocking of equipment could be observed in Pure Condensate system (KDA), some belonging to Operations with clear markings, and others from Commissioning without any indication. Another example is on firefighting system 3SGA, the valve 3SGD90AA204 was secured in position by means of a makeshift tin can.

Events:

- During September 2018, two cases of unauthorized manipulation of locked-out and tagged equipment were registered: condensate valve (3LCM68AA006) and a feed water pump and its associated suction valve. Two other events linked with inadequate electrical lock out occurred in March and May 2019.

Without proper control tagging and isolation of equipment, the safety of personnel and plant cannot be ensured.

Recommendation: The plant should improve its practices in tagging and isolation to ensure the safety of personnel and plant.

IAEA bases:

SSR-2/2 (Rev 1)
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.

NS-G-2.14
6.24. Areas in the plant and systems and their associated components should be clearly and accurately marked, allowing the operator to identify easily the equipment and its status. Examples of such systems are isolations, positions of motor operated and manually operated valves, trains of protection systems and the electrical supply to different systems.

7.21. Guidance for the isolation and tagging processes should be established to ensure the protection of personnel and equipment and status control of the tagging boundary and all components within the boundary. A training programme for the tagging and isolation processes should be established and all staff involved in the tagging and isolation of equipment should be trained and regularly retrained.

7.22. Suitable arrangements should be made for locking, tagging or otherwise securing isolation points to ensure safety. Locking devices for breakers and switches should be adequate to prevent the inadvertent startup or incorrect positioning of equipment. Out of service systems and components should be identified by means of appropriate signs and tags, both in the plant and in the control room. If it is impossible to de-energize all equipment or components within an isolation boundary, the management should ensure that the supervisor and the work group fully understand which equipment is energized and where it is located.

7.23. The rules for carrying out electrical and mechanical isolations and issuing radiation work permits should be published and adhered to. A qualified person from the operations department should verify the isolation procedures and checklists. Tags should be periodically reviewed for their accuracy and continued applicability.

7.30. A record of all active tagging requests and the positions of all tagged components should be made available to the control room operators to allow them to determine readily how the tagging will affect operations. Requests for tags to be placed in the plant should be reviewed periodically by management to verify the need for each request.

3.6 FIRE PREVENTION AND PROTECTION PROGRAMME

3.6(1) Issue: The plant's fire prevention and fire suppression arrangements are not fully developed and implemented to ensure that fire risk is minimized.

The team noted the following:

- Fire Prevention
  - A contractor staff was performing grinding and welding work creating sparks on a scaffolding platform without a fire-resistant cover and without a fire watch in the area near the secondary side chemistry system (near flange with ID 8LDR06AA003). Underneath the scaffolding platform there were floor coverings that could be susceptible to fire. A fire had previously occurred in the reactor pressure vessel in similar circumstances.
  - On 18 October 2018, in Unit 3 Turbine Hall, covering sheets on a cable tray below the site of welding works ignited.
- During a plant tour, several fire doors and cable penetrations were found open. For example:
  - The closing mechanism on a fire door was found to be defective in reactor building (RB) A007/1. No indication could be found if this defect had already been recorded in the corrective action programme.
  - The fire door in room 1365 had a broken door closer. The plant staff explained that it was not broken, but deliberately unhooked.
  - The fire door in room 1318 was found with an unattached seal. It was not possible to determine if this deviation had been noted.
  - Cable penetration 3EN470104B05J022 was not sealed due to cable pulling work. Some temporary sealing bags were laying on the ground. The work was planned for approximately 2 weeks, but there were no visible temporary mitigation measures.
- A Manager stated that the requirement on Unit 3 was to minimize fire load but there was no requirement to have a permit. As a result, it was not possible to know if the additional fire load was bounded by the fire analysis. It was also stated that it was not possible to have an updated list of actual deviations on opened fire doors, quantity and location of additional fire loads and flammable products on Unit 3. The manager indicated that this information would be available after first fuel loading.
  - The plant had not yet produced a list of buildings and rooms for unit 3 with elevated fire risk.
  - Floor coverings in multiple locations including Switch yard corridor, I&C Cabinet near the MCR and the MCR itself were not assessed as additional fire load.
- Fire Suppression

Several deviations were found on portable extinguishing system:

  - The contents gauge on a fire extinguisher in room 1351a showed empty.

  - Two fire extinguishers were found in the Essential Service Water Supply (ESWS) building with the validity date expired.
  - A chair was obstructing access to 3 firefighting extinguishers next to lift 3SNJ19.
- Several deviations were observed on fire hose cabinets, for example:
  - 3 fire hose cabinets in the reactor building were found locked in 3UNA24AA302, 3UNA24AA309 and 3UNA24AA213 with the emergency key to open (behind glass door) being absent.
  - On fire hose cabinet H-002H, two series mounted valves were in the closed positions. Plant personnel said that one should have been in the open position (outside the cabinet) and one in the closed position (inside the cabinet).
- Field Operators said they were not trained to use fire hoses, they were not able to state the availability of the system and they did not know who was in charge of their use even though there were clear requirements for personnel to attempt to extinguish a fire.

Without full development and implementation of the fire prevention and fire suppression arrangements, the probability of fire can increase.

Recommendation: The plant should improve the development and implementation of fire prevention and fire suppression arrangements in the plant to ensure that fire risk is minimized.

IAEA bases:

SSR-2/2 (Rev.1)
5.21. The arrangements for ensuring fire safety made by the operating organization shall cover the following: adequate management for fire safety; preventing fires from starting; detecting and extinguishing quickly any fires that do start; preventing the spread of those fires that have not been extinguished; and providing protection from fire for structures, systems and components that are necessary to shut down the plant safely. Such arrangements shall include, but are not limited to: Control of combustible materials and ignition sources, in particular during outages; Inspection, maintenance and testing of fire protection measures; Establishment of a manual firefighting capability; Assignment of responsibilities and training and exercising of plant personnel.

NS-G-2.1
2.13. Effective procedures for inspection, maintenance and testing should be prepared and implemented throughout the lifetime of the plant with the objective of ensuring the continued minimization of fire load, and the reliability of the installed features for detecting, extinguishing and mitigating the effects of fires, including established fire barriers.

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

6.6. Administrative procedures should be established and implemented to provide effective control of temporary fire loads in areas identified as important to safety during maintenance and modification activities. These procedures should cover combustible solids, liquids and gases, their containment and their storage locations in relation to other hazardous material such as oxidizing agents. They should include a procedure for issuing work permits that requires in-plant review and approval of proposed work activities prior to the start of work to determine the potential effect on fire safety. The on-site staff member responsible for reviewing work activities for potential temporary fire loads should determine whether the proposed work activity is permissible and should specify any additional fire protection measures that are needed (such as the provision of portable fire extinguishers or the use of a fire watch officer, as appropriate).

7.1. A comprehensive programme should be established and implemented to perform appropriate inspection, maintenance and testing of all fire protection measures (passive and active, including manual firefighting equipment) specified as important to safety. The specific fire protection systems, equipment, components and emergency procedures included in the programme should be identified and documented. Where such documentation is not available (for example, if the fire hazard analysis has not yet been performed and other documentation is incomplete), all fire protection measures should be assumed to be important to safety unless the contrary assumption can be justified.

7.2. The inspection, maintenance and testing programme should cover the following fire protection measures:

- passive fire rated compartment barriers and structural components of buildings, including the seals of barrier penetrations;
- fire barrier closures such as fire doors and fire dampers;
- locally applied separating elements such as fire retardant coatings and cable wraps;
- fire detection and alarm systems, including flammable gas detectors;
- emergency lighting systems;
- water based fire extinguishing systems;
- a water supply system including a water source, a supply and distribution pipe, sectional and isolation valves, and fire pump assemblies;
- gaseous and dry powder fire extinguishing systems;
- portable fire extinguishers;
- smoke and heat removal systems and air pressurization systems;
- communication systems for use in fire incidents;
- manual firefighting equipment including emergency vehicles;
- respirators and protective clothing for radiological applications;
- access and escape routes for firefighting personnel;
- emergency procedures.

4. MAINTENANCE

4.2 MAINTENANCE FACILITIES AND EQUIPMENT

The Plant had developed an in-house software solution for the administration of Maintenance work orders in the field utilizing a handheld device. The tool synchronizes data from the work order and provides access to pertinent information at the point of work. The handheld device also enables workers to scan a barcode on the component to be worked on and match it with the work instruction. Further benefits include the enhanced evaluation of maintenance schedules by monitoring activities and worker performance, this was done through the inclusion of start and completion times. The team identified this as good performance.

4.5 CONDUCT OF MAINTENANCE

The team identified that the plant's lifting and rigging activities were not always prepared, controlled and implemented in a manner that ensured the integrity and availability of equipment and reduced the risk of harm to personnel. For example, lifting and rigging equipment was used outside of its inspection date and the management of work areas during lifting operations was inadequate. The team made a recommendation in this area.

The team identified that plant maintenance activities were not always prepared, controlled and implemented in a manner that ensured equipment and personnel safety. For example, inappropriate tools and equipment were used, work areas were not always properly controlled or organised, and the storage of tools and plant items such as fasteners and gaskets were not always properly organized. The team made a suggestion in this area.

4.6 MATERIAL CONDITION

The team identified that the Foreign Material Exclusion (FME) programme was not consistently implemented to prevent the ingress of foreign material into systems and components of the Plant. For example, there was an inadequate use of FME protection and use of inappropriate types of FME covers during maintenance, installation activities and spares management. Furthermore, there was a lack of readily available FME equipment. The team made a recommendation in this area**.**

DETAILED MAINTENANCE FINDINGS

4.5 CONDUCT OF MAINTENANCE

4.5(1) Issue: The Plant's lifting and rigging activities are not always prepared, controlled and implemented in a manner that ensures the integrity and availability of equipment and reduces the risk of harm to personnel.

The team noted the following;

- During work to install a spool on Unit 3 Condensate Extraction Pump 3LCB:
  - A scaffold frame used by contractor staff to attach rigging equipment to support a pipe spool during installation on Unit 3 Condensate Extraction Pump 3LCB, (approximate weight 150kg, 600mm diameter, 1m long), was found without a valid inspection date on the scaffold tag on 21 November 2019 The scaffold was erected on 30 October 2019 and should have been inspected every 7 days, but three inspections had been missed.
  - Rigging equipment being used by contractor staff, (including two 1 tonne fabric slings and one 0.75 tonne pull lift), during the lifting operations on Unit 3 Condensate Extraction Pump 3LCB had not been inspected within the permitted inspection period. The dates on the inspection tag indicated May 2018 and the sling should have been inspected every year but was 6 months past its inspection date.
  - A fabric rigging sling removed from the scaffold frame with the reference No 9665 was left on the floor without any protection.
  - To accommodate an overhead cable tray, the rigging of Unit 3 Condensate Extraction Pump 3LCB Filter spool by contractor staff was positioned off centre of the load; the pipe spool, (approximate weight 150kg, 600mm diameter, 1m long), was slung at an angle of approximately 20 degrees. This caused the chain to pull against the cable tray and associated earth bonding cable, potentially compromising its integrity.
- During work on oil cooler 2MAV02BC001;
  - Work area demarcation was not in place during the lifting of oil cooler tube nest 2MAV02BC001 (approximate weight 5 tonnes), pedestrians were seen to walk by the point of work whilst the lifting operation was in progress. A scaffold working party also entered the area to modify the access scaffold whilst the lift was ongoing; and was not challenged. Furthermore, there were no work area barriers in place when the tube nest was lowered to its storage position within a vertical transport frame.
  - A rigger working on heat exchanger 2MAV02BC001, assisted another worker to remove the tube nest whilst concurrently communicating with the crane driver by mobile phone; there was no clear line of sight to the crane driver at this time presenting a risk to the working party due to inadequate communications.
  - The transport frame for oil cooler tube nest 2MAV02BC001 was secured by lifting slings and shackles to a pedestrian stairway handrail, this is not the intended use of a handrail and may compromise its integrity. To attach the oil cooler securing straps, workers used the stairway as a working platform, at some points leaning through the handrail. These working methods placed the workers at an increased risk of fall.

- Lifting accessory eye rings, that are intended to remain integral with a lifting component after installation, were found as ‘loose’ items within the active workshop; these could be used independently without an appropriate test certificate or unique identification marks being available; this is not in line with the industry requirements for lifting and rigging equipment.

Plant events:

- In September 2018, the travel rope of 32 tonne crane 2FCJ17AE002 broke resulting in the fall of the lifting block .
- In April 2019, during the transport of a control rod from its stand to a designated area in the protective tube block, the rod became disconnected allowing it to fall approximately 3 metres to the floor; this was a repeat event from October 2018.

Inadequate preparation and control of lifting and rigging activities can increase the risk of harm to personnel and damage to equipment

Recommendation: The Plant should improve the preparation and control of lifting and rigging activities to ensure safety of personnel and equipment.

IAEA Bases:

SSR-2/2 (Rev.1)
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.

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-2.6:
3.8. Contractors should be subject to the same standards as plant staff, particularly in the areas of professional competence, adherence to procedures and evaluation of performance. Suitable steps should be taken to ensure that contractors conform to the technical standards and the safety culture of the operating organization.
8.19. Plant management should provide suitable mobile lifting and transport facilities, with clear indications of their lifting capacity. In the selection and use of these facilities, due account should be taken of the possible radiological consequences of their failure. Examples of precautions taken include regular examination and maintenance of lifting equipment, periodic testing, special inspections before major operations involving lifting and rigging, and cautionary notices limiting movements of loads over specified areas. All operations involving lifting and rigging should be performed by trained personnel.

4.5(2) Issue: Plant maintenance activities are not always prepared, controlled and implemented in a manner that ensures equipment and personnel safety.

The team noted the following:

- During preventative maintenance of hot standby water pump 2XJG0AP002, a hand-made packing material removal tool was used which was misshapen and had no protective handle to prevent personal injury. Also, a bladed knife was used to cut packing material and left with its blade open on the floor, presenting a cut hazard where workers were knelt.
- Screwdrivers were used to push gland packing into position during the preventative maintenance on hot standby water pump 2XJG02AP002, which risked damaging the packing material. Screwdrivers were also used to force fit gland followers.
- During the installation of Unit 3 condensate extraction pump 3LCB filters by contractor staff, spanners were laid on the floor or on the threads of freshly cleaned bolts, causing potential damage to fasteners. Bolts about 25mm diameter and 300mm long were laid on top of adjacent valve flanges presenting a risk of dropped objects. In addition, due to poor lighting levels, the workers were expected to use head torches, but they did not.
- A worker did not wear gloves whilst collecting residual oil during the removal of cooler 2MAV02BC001, a bucket of oil was also left on the scaffold platform presenting a fire and environmental risk, the same worker was observed without gloves applying oil during the replacement of the cooler. Furthermore, plastic sheeting attached to prevent oil dripping during transportation of the cooler tube nest was inappropriately secured with red and white barrier tape which is not its intended purpose.
- Newly cut joints for oil cooler 2MAV02BC001 were hung on a valve spindle with other items including work coats and a tool bag; which risked damaging the joint prior to installation.
- Workshop machines in the Maintenance facility were found unlocked, allowing uncontrolled access to unauthorised users.

Inadequate preparation, control and implementation of maintenance activities can lead to an increased risk of personal injury and impaired equipment performance.

Suggestion; The Plant should consider improving its preparation, control and implementation of maintenance work activities to ensure personal and equipment safety.

IAEA Bases:

SSR-2/2 (Rev1)
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.

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-2.6

3.8. Contractors should be subject to the same standards as plant staff, particularly in the areas of professional competence, adherence to procedures and evaluation of performance. Suitable steps should be taken to ensure that contractors conform to the technical standards and the safety culture of the operating organization.

4.6 MATERIAL CONDITION

4.6(1) Issue: The Foreign Material Exclusion (FME) programme is not consistently implemented in the plant to prevent the ingress of material into the systems and components.

The team noted the following:

- Electrical panels on switchboards 3BJA25 and 3BJB21 were found withdrawn and locked in the open position with no FME covers fitted; the exposed internals risk the introduction of foreign material with a potential for flash over when the circuit is reenergised.
- An unlocked lock was observed hanging on electric cubicle 3MKC01AA001-M1, immediately above racked out electric cubicles. The lock could easily have fallen inside.
- The Unit 3 refuelling machine area had been handed over to Technical Operations with foreign materials items evident including small tools, metal objects and small clips. FME entry controls were in place but these items had not been identified. Additionally, there was no foreign material protection over a 15cm hole in the cover of the fuel pond.
- During a visit to fresh fuel room No A407/1, no FME briefing was provided on entry to the fresh fuel receipt and handling area. In addition, no FME protection was provided for small personal items such as pens, glasses or badges, also transparent plastic bags were seen at different locations within the FME zone.
- On the 9.6m level of Unit 3 Turbine hall, approximately six large bore pipes, (75mm to 100mm diameter), had inadequate or missing Foreign Material Exclusion covers.
- Two small bore pipes on heat exchanger 2MAV02BC001 did not have foreign material exclusion covers fitted, one other small-bore pipe was covered with a large plastic waste bag. After removal of the tube nest from the cooler body, a polythene foreign material exclusion sheet was placed over the opening, however this was not secured to prevent the ingress of debris. Subsequently, the upper tube nest openings were not covered to prevent material entering them. Furthermore, a foreign material exclusion cover was used to carry fasteners; this is not its intended function.
- During work by contractor staff on U3 Condensate Extraction Pump 3LCB Filters, the outlet stubs of the inlet and outlet pressure monitoring tapping points had their openings covered by tape, not the required Foreign Material Covers. Furthermore, polythene sheeting used to cover the outlet flanges of condensate pumps 3LCB04AP-001 and 3LCB05AP-001 were torn increasing the risk of foreign material inclusion.
- Within the stores building there were approximately 20 lengths of tube and pipe on various racks including the Foreign Material Exclusion High storage rack, which did not have FME covers fitted as required. In addition, a type of internal push-fit FME cover was in use that is susceptible to being pushed into pipe ends and becoming foreign material itself.
- During the installation of the tube nest on oil cooler 2MAV02BC001, plant supplied compressed air was used to blow through the tubes of the cooler. The use of compressed air to clean plant items risks the re-entrainment of foreign material into the plant item.

Plant Events:

- In April 2018 foreign material was identified in the head of the reactor main control rod assembly absorber.

- In October 2018 foreign materials were identified in the bottom of the Pressurizer and in the outlet holes of the Pressurizer spray system.
- In November 2018 during testing of Emergency Cooling System pump 8JNR10AP002, the pump had to be shut down multiple times due to low suction pressure. The cause of the low pressure was clogging of the inlet mesh 8JNR10AT002 caused by the build-up of paper and duct tape pieces in the filter.

A lack of rigorous implementation of the foreign material exclusion programme puts at risk equipment safety and the integrity of nuclear fuel.

Recommendation: The Plant should improve the implementation of its Foreign Material Exclusion programme.

IAEA Bases:

SSR-2/2 (Rev.1)
7.11. An exclusion programme for foreign objects shall be implemented and monitored.

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.

NS-G-2.5:
6.8 Maintenance programmes should include procedures to prevent the introduction of foreign materials into the reactor.

5. TECHNICAL SUPPORT

5.6. SURVEILLANCE PROGRAMME

The team observed that inspection, testing and trouble-shooting of some important safety related equipment and systems were not conducted in a manner that would ensure their ability to support reliable plant operations. For example, the spent fuel pool residual heat removal pumps were only visually checked once after installation in 2012, and when the motors were changed, the changes to function test documents were not validated properly. The team made a suggestion in this area.

5.7. PLANT MODIFICATION SYSTEM

The team observed that in the area of equipment seismic qualification activities, the plant had a relatively large number of outstanding activities to be resolved before the unit commences operation, for example the seismic restraints for cranes and other important equipment had not been installed. The team encouraged the plant to expedite work in this area.

5.8. REACTOR CORE MANAGEMENT (REACTOR ENGINEERING)

The team observed that the plant had a relatively large number of outstanding works associated with the receipt, handling and storage of fresh fuel, these included the readiness and cleanliness of fresh fuel room and refuelling pool areas. The team encouraged the plant to continue improvements in this area before the first fuel load.

DETAILED TECHNICAL SUPPORT FINDINGS

5.6. SURVEILLANCE PROGRAMME

5.6(1) Issue: Inspection, testing and trouble-shooting of some important safety related equipment and systems are not conducted in a manner that ensures their ability to support reliable plant operations.

The team noted the following:

- Spent Fuel pool residual heat removal pumps (3FAK11, 3FAK12 & 3FAK16) were installed in 2012 but were not operated for five years. There was a requirement to carry out annual checks on five pump parameters during prolonged periods of non-operation. However, only a visual check had been carried out.
- The spent fuel pool residual heat removal pump motors were changed, and the new motors had different operating characteristics. The function test documentation was produced for the original pump, and handwritten amendments were made to the documentation for the success criteria of test parameters. However, these handwritten amendments did not go through any validation process and the test was signed off as acceptable.
- During the first start of the pump motors on the spent fuel pool residual heat removal system, the measured current value exceeded the criteria in the functional test documentation. The pump manufacturer was contacted to confirm if the test results were acceptable. However, the test was signed off as successful before the confirmation from the manufacturer was received. In addition, the manufacturer requested some additional checks to be made for noise and any other strange parameter measurements, however, these were not recorded.
- An issue with Heating Ventilation and Air Conditioning (HVAC) settings was identified by the plant. During a non-conformance report screening meeting, this was identified as a repeat issue and related to two previously identified issues. No clear understanding of the cause of the issue was presented and further testing was planned, however no systematic approach to resolving the issue was evident.

Without proper inspection, testing and trouble-shooting of important safety related equipment and systems, their ability to support reliable plant operations could not be ensured.

Suggestion: The plant should consider improving the inspection, testing and trouble-shooting of safety related equipment and systems to ensure they can support reliable plant operations.

IAEA Bases:

SSR-2/2 (Rev.1)

6.13. Authorities and responsibilities shall be clearly specified and shall be delegated to the individuals and groups performing the commissioning activities. The operating organization shall be responsible for ensuring that construction activities are of appropriate quality and that completion data on commissioning activities and comprehensive baseline data, documentation or information are provided. The operating organization shall also be responsible for ensuring that the equipment supplied is manufactured under a quality assurance programme that includes inspection for proper fabrication, cleanliness, calibration and verification of operability.

6.14. During construction and commissioning, the plant shall be monitored, preserved and maintained so as to protect plant equipment, to support the testing stage and to maintain consistency with the safety analysis report.
8.1 Maintenance, testing, surveillance and inspection programmes shall be established that include predictive, preventive and corrective maintenance activities. These maintenance activities shall be conducted to maintain availability during the service life of structures, systems and components by controlling degradation and preventing failures. In the event that failures do occur, maintenance activities shall be conducted to restore the capability of failed structures, systems and components to function within acceptance criteria.
8.2 The operating organization shall establish surveillance programmes for ensuring compliance with established operational limits and conditions and for detecting and correcting any abnormal condition before it can give rise to significant consequences for safety.

NS-G-2.4
6.42. The surveillance programme should ensure that items important to safety continue to perform in accordance with the original design assumptions and intent and may incorporate the results of PSAs and feedback from operating experience. The programme should include requirements for evaluation and review to detect in a timely manner degradation and ageing of structures, systems and components that could lead to unsafe conditions. This programme should cover monitoring, checks and calibration, and testing and inspection complementary to the in-service inspection.

NS-G-2.6
2.11. The objectives of the surveillance programme are: to maintain and improve equipment availability, to confirm compliance with operational limits and conditions, and to detect and correct any abnormal condition before it can give rise to significant consequences for safety. The abnormal conditions which are of relevance to the surveillance programme include not only deficiencies in SSCs and software performance, procedural errors and human errors, but also trends within the accepted limits, an analysis of which may indicate that the plant is deviating from the design intent.
9.2. The surveillance programme should fulfil the following functions:

– delineating in sufficient scope and depth the aims of surveillance in accordance with operating limits and conditions and other requirements that are applicable to SSCs important to safety;
– specifying the frequency of surveillance and providing for the scheduling of surveillance activities;
– specifying standards to be applied and providing for appropriate procedures to be followed in the conduct and assessment of each surveillance activity
– verifying that SSCs important to safety remain within the operational limits and conditions;
– indicating the points at which tests are required and deficiencies, if any, are rectified;
– specifying the requirements for records to be kept and for the retention and retrievability of such records;

9.7. The surveillance programme should be developed by the operating organization sufficiently early to permit it to be properly implemented as and when plant items become operational in the commissioning phase or, where appropriate, upon installation.

Implementation should be scheduled such that the safety of the plant does not depend on untested or unmonitored SSCs.

9.9. In preparing and reviewing the surveillance programme, special attention should be paid to ensuring that, whenever surveillance tests are carried out, control of the plant configuration is maintained and sufficient redundant equipment remains operable, even when the plant is shut down, to ensure that no operational limits and conditions are violated.

6. OPERATING EXPERIENCE FEEDBACK

6.1. ORGANIZATION AND FUNCTIONS

The team noted that the Operating Experience Feedback (OEF) programme was not fully established and rigorously implemented in the areas of reporting, trending and analyzing operating experience; management of corrective actions and the use of operating experience to prevent repeat events. The operating experience feedback programme was decentralized with different procedures and databases. The OE procedures had different expectations for the reporting of deficiencies and actions. Not all deficiencies which were identified were recorded in the plant databases. Deficiencies were noted in the quality and monitoring of corrective actions and root cause analyses. The plant did not have a corrective action database that allowed for the effective administration, tracking and management of corrective actions at Unit 3. The team made a recommendation in this area.

The team noted that the plant had not implemented the system for retraining of personnel involved in event analysis. The team encouraged the plant to review and improve in this area.

6.9. EFFECTIVENESS REVIEW OF THE OPERATING EXPERIENCE PROGRAMME

The team noted that the operating experience programme was not periodically evaluated to determine its effectiveness and identify deficiencies in the process. No monitoring of the implemented parts of the OE process was performed by the corporate organization and the team encouraged the plant to work with corporate to improve in this area.

DETAILED OPERATING EXPERIENCE FINDINGS

6.1. ORGANIZATION AND FUNCTION

6.1(1) Issue: The Operating Experience (OE) programme is not fully established and rigorously implemented in the areas of reporting, trending and analyzing of operating experience, management of corrective actions, and use of operating experience to prevent repeat events.

The team noted the following:

Organization:

- Implementation of the Operating Experience Feedback (OEF) process was still in progress at Unit 3, and discussions were ongoing to determine the scope and responsibilities after planned fuel loading. However, priority had not been set for the programme's implementation.
- The activities related to operating experience feedback were not managed by a centralized department, instead they were managed by two different departments: commissioning and construction.

Reporting:

- The threshold for reporting deficiencies in unit 3 was high. For comparison Units 1 and 2 report 6000 deficiencies per unit per year. However, in Unit 3 in 2018 there were a total of 358 records in the SAP Nuclear system, and in 10 months of 2019, a total of 400 records. For comparison, during a 3 hour plant tour approximately 200 deficiencies were identified by the team.
- Not all deficiencies identified by personnel from the Operations Preparation Department were recorded in the plant database. Deficiencies were recorded in the database in cases where it was necessary to take other measures. Deficiencies which were solved directly were not usually reported.

Analyzing and Trending

- During 2018 about 14 equipment modules (CAS AV42M) were found damaged. The root cause of the events could not be determined in 2018. The corrective measures were adopted based on the apparent cause and were not effectively implemented. The root cause was eventually determined during the analysis of further failures of the modules in 2019.
- The root cause investigation of event 'Fall of inserted control rod during revision in A501/1' identified two direct causes, but no root cause was identified.
- Three root cause analysis of events were initiated at Unit 3 in 2019. In November 2019 it was identified that the root cause analysis of two events that occurred earlier in the year had not been completed . The deadline for the analysis was not established in the procedure. These events were: leakage of the essential service water branch, June 2019 and damaged pressurizer electroheater, in March 2019.
- The recording of non-conformities was performed through different databases (for example CAPA, SAP Nuclear, and CSI). There was no clear criteria and detailed

procedure on which database to use. There was no overall collation of trend analysis findings from different databases.

- There was no unified coding system for coding of records in different databases at Unit 3. The Corrective and Preventive Action (CAPA) database did not include coding fields for trending. CSI used a different code system to that used in SAP Nuclear.
- The formal common cause analysis of several radiography events was not performed.
- Quality reviews were not performed on completed event analysis reports from Unit 3, they were only discussed at the Commissioning Committee and the Construction Committee.
- There was no formal requirement to perform trending analysis of records in CAPA database or separate analysis of records in SAP Nuclear from unit 3.

Corrective actions:

- A root cause analysis was performed for the event 'Fall of inserted control rod'. The analysis resulted in two corrective actions but they had neither a responsible person nor a deadline defined. They were not registered in the plant corrective action system and no follow up tracking was performed by the plant.
- Following a discussion of shortcomings on radiography work during commissioning, several corrective actions were taken to prevent the recurrence of similar events. None of these measures had a responsible person or deadline defined.
- No corrective actions were developed to solve issues identified by the Independent Nuclear Oversight (INOS) Independent review of OEF process at Unit 3 even though three areas for improvement were identified.
- There was no requirement in the procedures to prioritize corrective actions approved by the Construction or Commissioning Committees.
- Corrective actions taken in response to different types of findings and issues were kept in different databases (SAP, CSI, CAPA, and Lotus Notes). Multiple databases rendered overall tracking of corrective action progress more difficult.
- In November 2019 it was identified that two of the corrective actions for the event Activation of Engineered Safeguards Features Actuation System (ESFAS) signal 'Earthquake' had not been completed. The deadline of the corrective action was postponed three times. The original deadlines were 30 April 2019 and 1 May 2019 respectively.

Use of operating experience:

- The process of transmitting equipment history to the Operations Department was not established. The deficiencies identified with the preparation and operation of the equipment during commissioning had not always been registered or were registered in various databases which did not always allow easy retrieval of historical data.
- There were deficiencies in the transfer of OE from Units 1 and 2 to Unit 3.
  - On 11 April 2018 the unit 3 refuelling machine manipulator hitch was damaged. An identical event occurred at unit 1 on 1 April 2017.

- On 27 September 2019 deformation of the water channels of cooling towers occurred. One of the apparent causes of the event was that the improvement which had been applied at Unit 1 and 2 cooling towers, had not t been executed in unit 3.

Without a comprehensive and fully implemented OEF programme, the likelihood of repeat events could increase.

Recommendation: The plant should improve the operating experience feedback programme and its implementation to prevent the occurrence of repeat events.

IAEA Bases:

SSR-2/2 (Rev.1)

Requirement 24: Feedback of operating experience
The operating organization shall establish an operating experience programme to learn from events at the plant and events in the nuclear industry and other industries worldwide.

5.27. The operating organization shall establish and implement a programme to report, collect, screen, analyse, trend, document and communicate operating experience at the plant in a systematic way. It shall obtain and evaluate available information on relevant operating experience at other nuclear installations to draw and incorporate lessons for its own operations, including its emergency arrangements. It shall also encourage the exchange of experience within national and international systems for the feedback of operating experience. Relevant lessons from other industries shall also be taken into consideration, as necessary.

NS-G-2.4
6.62. An effective programme for the review of operating experience should be established to provide methods to analyse both in-house events and events in the nuclear industry generally so as to identify plant specific actions needed to prevent the occurrence of similar events. In-house events of interest to other plants should be shared with the industry to prevent the occurrence of similar events. The effectiveness of the operating experience review programme should be assessed periodically to identify areas of weakness that require improvement.

SSG-50
2.4. An effective operating experience programme should include the following main elements:

(a) Identification and reporting of internal operating experience;
(b) Collection of external operating experience;
(c) Screening of operating experience, including immediate review of events of specific interest;
(d) Investigation and in-depth analysis of relevant operating experience;
(e) Trending and review for timely recognition of developing issues;
(f) Management of corrective actions resulting from investigation and analysis of operating experience, including approval, implementation, tracking and evaluation of their effectiveness;
(g) Use, dissemination and exchange of operating experience, including through national and international reporting systems;
(h) Review of the effectiveness of the operating experience programme;
(i) Maintenance of a storage, retrieval and documentation system for operating

7. RADIATION PROTECTION

7.1. ORGANIZATION AND FUNCTIONS

The team observed that some aspects of the radiation protection programmes are not complete and some worker practices are not always conducted in a manner that ensures the safety of personnel and dose minimization. Examples included the control of entries into very high radiation areas where the radiation protection officer was not identified as the person to approve such entries. Keys for accessing very high radiation areas were not adequately controlled. The alpha radiation control programme was incomplete, and there was an absence of an interdisciplinary hot spot reduction programme. Worker practices did not always meet the required standard, examples include: entry to a hot spot area without the use of an appropriate radiation meter, and workers stepping over clean areas with potentially contaminated shoe covers. The team made a recommendation in this area.

The team found radiological respiratory protection devices were used in the plant without the workers performing a face fit test to confirm the correct fit of the respirator. The team encouraged the plant to improve in this area.

7.5. RADIATION PROTECTION INSTRUMENTATION, PROTECTIVE CLOTHING AND FACILITIES

The team observed the plant radiation protection instrumentations calibration and facilities are not managed in a manner which ensured their timely availability, reliability and accuracy. Examples included the absence of calibration schedules for radiation protection instrumentation for Unit 3, incomplete procedures and a lack of knowledge of the required resource to perform instrument calibrations. In addition, the dosimetry laboratory had no environmental controls to ensure the proper function of the dosimeters. The team made a suggestion in this area.

The team identified that the radiation instrumentation monitoring panel, installed at the main radiation protection control room, provided comprehensive information on the internal and external radiological conditions of the plant. The team considered this as a good performance.

DETAILED RADIATION PROTECTION FINDINGS

7.1. ORGANIZATION AND FUNCTIONS

7.1(1) Issue: Some aspects of the radiation protection programmes are not complete and some worker practices are not always conducted in a manner that ensures the safety of personnel and dose minimization.

The team noted the following:

Radiation protection control measures:

- The operational procedure for accessing very high radiation areas had no provision for approval from the plant's radiation protection officer; this allowed entries in very high radiation areas without evaluation or authorization from a radiation protection officer.
- The keys for accessing very high dose rate areas at the plant were kept on a board on the wall in the main radiation protection control room. However, there was no locker for such keys.
- On the radiation work permit, there was no information regarding the alarm set points of the electronic dosimeter to be respected by the worker.
- The set point for generic works in controlled area at low levels of radiation was set too high to allow for earlier detection of possible abnormalities, for example, with an ambient dose rate of 50 microSv/h, the alarm set point was 1000 microSv/h.
- The radiation work permits did not include information regarding alpha contamination levels.
- The plant did not have a complete programme for alpha hazards control. The susceptibility for alpha internal contaminations was not known, based on the surveys and/or on the ratio of beta, gamma and alpha classification.
- The plant did not have a formal programme for source term reduction, more specifically regarding hot spots. The plant had a list of hot spots, but there were no regular interdisciplinary meetings, no history or types of actions to eliminate the hot spots. The survey status was not updated, it was dated from 2018 or early 2019.
- The plant´s ALARA committee was a group drawn from the radiation protection organization, chaired by the radiation protection manager and included only radiation protection supervisors as regular members. Any other participation was under invitation, and the presence of managers from other plant areas was not mandatory, potentially compromising the ALARA principle. In addition, there was no formal process to get ALARA feedback from other departments in the plant.
- The database of radiation surveys was not integrated in a single platform, but spread in several Microsoft Excel files. The maps were not indexed with the recorded data, and there was no history of a building, a room, a system, or a point. Since there was no regular, established frequency for surveys to be performed on the plant, except following outages or for special services demanding a radiation work permit, the files containing the record of the plant´s surveys were not current. The last recorded survey was on 26 April 2019.

- The radiation surveys were not performed on entire roofs but were limited to the area close to ventilation stacks. Surveys were made on internal routes in uncontrolled areas after movement of fuel or radioactive materials during outages, but there was no regular frequency to perform radiation and contamination surveys on the uncontrolled areas of plant buildings.
- Workers coming from controlled areas were instructed to wash their hands before going to the portal contamination monitor. As a result, contamination on the hands, caused by very high activity of a point source, could go undetected, resulting in dose to skin not being assessed.
- There was no contamination monitor at the exit of each radiochemistry laboratory or from the chemistry area.
- Radiochemistry laboratories were not posted with contamination levels.
- Radiation hazard notices were not posted on several baskets containing contaminated bags in the radwaste processing facility, resulting in personnel not being informed of possible radiation levels.
- On leaving the posted contamination-controlled area in the environmental laboratory, workers were required to use a hand and foot monitor. However, the monitor was installed inside the posted contaminated area, increasing the probability of contamination of the detectors and increasing background radiation levels, thus adversely impacting the minimum detection level of the equipment.

Related to worker practices:

- A radiation protection technician entered a room with a post on the door indicating a hot spot of 48 mSv/h inside the room. The technician only used a handheld monitor, and not an extendable probe detector, to identify and measure the hot spot. When challenged, instead of going back and fetching an extendable probe detector, the technician decided to continue. This was not challenged by his supervisor.
- Three workers undertaking work in the controlled area were not aware about the set point of alarms on their electronic dosimeters.
- At the posted contamination-controlled area of an environmental laboratory, the workers were stepping in and out without wearing or removing cover shoes as required.
- The plant recently experienced five events related to radiography. In one of the events, a chemist was authorized to pass through a fenced area to collect samples when radiography operation was on going which resulted in an alarm on their dosimeter.

Without complete radiation protection programmes and proper work practices, the safety of personnel and the goal of dose minimization could not be ensured.

Recommendation: The plant should improve its radiation protection programmes and work practices in some areas to ensure safety of personnel and minimization of radiation dose.

IAEA Bases:

GSR Part 3
3.77. Employers, registrants and licensees:

(a) Shall involve workers, through their representatives where appropriate, in optimization of protection and safety;
(b) Shall establish and use, as appropriate, constraints as part of optimization of protection and safety.
3.94. Employers, registrants and licensees…
(c) Shall make the local rules and procedures and the measures for protection and safety known to those workers to whom they apply and to other persons who may be affected by them;
(d) Shall ensure that any work in which workers are or could be subject to occupational exposure is adequately supervised and shall take all reasonable steps to ensure that the rules, procedures, and measures for protection and safety are observed; …
3.96. Registrants and licensees, in cooperation with employers where appropriate, shall establish, maintain and keep under review a programme for workplace monitoring…
3.97. The type and frequency of workplace monitoring:
(a) Shall be sufficient to enable:
(i) Evaluation of the radiological conditions in all workplaces;
(ii) Assessment of exposures in controlled areas and supervised areas;
(iii) Review of the classification of controlled areas and supervised areas.
(b) Shall be based on dose rate, activity concentration in air and surface contamination, and their expected fluctuations, and on the likelihood and magnitude of exposures in anticipated operational occurrences and accident conditions.
3.110. Employers, in cooperation with registrants and licensees:
(a) Shall provide all workers with adequate information on health risks due to their occupational exposure in normal operation, anticipated operational occurrences and accident conditions, … and adequate information on the significance of their actions for protection and safety; …
5.13. All plant personnel shall understand and acknowledge their individual responsibility for putting into practice the measures for controlling exposures that are specified in the radiation protection programme. ...
5.16. The radiation protection programme shall ensure control over radiation dose rates for exposures due to activities in areas where there is radiation arising from or passing through structures, systems and components… It also addresses plant chemistry activities as well as exposures due to radioactivity of substances in the fuel coolant (liquid or gas) and associated fluids. The programme shall make arrangements to maintain these doses as low as reasonably achievable.

GSG-7
2.23. Requirement 5 of GSR Part 3 [2] states that "The principal parties shall ensure that protection and safety are effectively integrated into the overall management system of the organizations for which they are responsible." For occupational exposure in planned exposure situations, the principal party is the employer. ...
3.48. The management should plan work programmes so as to ensure, to the extent possible, that workers do not receive a dose corresponding to a significant proportion of the relevant dose limit in a short period of time, such that subsequent exposures might result in the annual dose limit being exceeded.
3.96. … In addition to a description of the work to be performed, the radiation work permit can include:
(a) A detailed dose rate map of the working area and possible hot spots, produced from a survey made prior to the work or otherwise estimated;

(b) An estimate of contamination levels and how they could change during the course of the work;
…
(g) Details of any time restrictions or dose restrictions;
7.234. The wearing of warning (alarm) dosimeters (or dose rate meters) can be effective in preventing serious exposures and may help in considerably reducing the dose incurred in the event of accidents...

7.5. RADIATION PROTECTION INSTRUMENTATION, PROTECTIVE CLOTHING AND FACILITIES

7.5(1) Issue: Plant radiation protection instrumentation calibration and facilities are not managed in a manner that ensures their timely availability, reliability and accuracy.

The team noted the following:

Radiation protection instrumentation (fixed and mobile)

- The person responsible for commissioning the Radiation Monitoring Systems (RMS) of Unit 3, stated that all the portable radiation instruments would be calibrated according to calibration procedures, which were not yet developed, before the end of February 2020. All the operators would be trained on the RMS before the end of December 2019. However, no formal or informal schedule supporting this plan and the related due dates was presented.
- The laboratory which calibrates the radiation monitoring instruments included two qualified persons assigned to the calibration programme, and these persons were performing the calibration programme for the plant and, at the same time, were required to calibrate all the mobile and fixed radiation instrumentation in Unit 3, which challenged the requirement to have the instruments operational before initial fuel load.
- The person in charge of calibration was not aware of the effort required to calibrate more than one hundred radiation detectors, which were installed at fixed radiation detection units in Unit 3. In addition, there was no formal or informal schedule presented to demonstrate the plan to calibrate the detectors in time to meet the target of initial criticality and the start of low power physics tests in March 2020.
- A manager from radiation protection suggested using the factory calibration results and, by performing random verification of calibration parameters on group of detectors, issuing temporary calibration certificates for all the radiation detection instruments, to accept them as operable in order to allow starting physical tests. However, this approach was not supported by a scientific document from the national metrology laboratory or any other accredited institution.

External dosimetry facility and instrumentation

- The control of environmental parameters was not apparent at the film dosimetry laboratory. The temperature value was controlled by turning on and off the air conditioner equipment and reading the temperature value indicated in the air conditioner´s panel. No indications were provided for humidity and pressure. For film dosimeters, the control of temperature is crucial, and for thermoluminescent dosimeter, the control of humidity and temperature are essential.
- The dosimetry laboratory was located inside a radiation-controlled area which could result in possible contamination, and reduced accuracy for dose determination.

Without managing the plant radiation protection instrumentations calibration and related facilities in a proper manner, their timely availability, reliability and accuracy could be challenged.

Suggestion: The plant should consider improving its management of radiation protection instrumentations calibration and facilities regarding their timely availability, reliability and accuracy.

IAEA Bases:

GSR Part 3

3.76. Employers, registrants and licensees shall ensure. that:

…

(e) Suitable and adequate facilities, equipment and services for protection and safety are provided, the type and extent of which are commensurate with the expected likelihood and magnitude of occupational exposure;

…

(g) Appropriate monitoring equipment and personal protective equipment is provided and arrangements are made for its proper use, calibration, testing and maintenance;

(h) Suitable and adequate human resources and appropriate training in protection and safety are provided, as well as periodic retraining as required to ensure the necessary level of competence; …

GSG-7

5.36. … It should be ensured that the most suitable instruments and sampling and measurement techniques are selected, and that proper attention is given to the calibration of instruments and the recording of data (see Section 7). …

7.103. Calibration should not be confused with adjustment of a measurement system, with ‘self-calibration’ or with verification.

7.104. For all measurement methods, instruments should be regularly calibrated, and this calibration should be traceable to recognized national standards. ...

8. CHEMISTRY

8.2 CHEMISTRY PROGRAMME

The laboratories in the plant applied a systematic international cross-measuring programme with good results. The plant laboratories applied the ‘General requirements for the competence of testing and calibration laboratories standard’ and had an accreditation in measuring waste waters and boric acid. The accreditation process and the proper international cross-measuring programme ensured the accurate measurement of chemical discharges to the environment. The team identified this as good performance.

The plant had the capability to directly collect and analyse samples through the life of the ion exchange resin in the nuclear island which enabled a more accurate assessment of remaining serviceable life. This would directly decrease the volume of radioactive waste produced. The team identified this as good performance.

8.3 MANAGEMENT OF CHEMISTRY DATA

The team observed that the Hot-hydro and Passivation programs during commissioning did not contain the analysis and reporting of all necessary corrosive components including Fluorite or Sulphate. Also, low solubility compounds were not included, for example; Calcium, Magnesium, and Aluminium. The team encouraged the plant to improve in this area.

8.6 QUALITY CONTROL OF OPERATIONAL CHEMICALS AND OTHER SUBSTANCES

The team observed that controls for the labelling and safe use of chemicals were not consistently implemented at the plant to ensure personnel and equipment safety. For example, the team identified improperly labelled chemicals in the field. In addition, chemicals were carried and used by workers inappropriately and these actions were unchallenged. The team made a suggestion in this area.

DETAILED CHEMISTRY FINDINGS

8.6 QUALITY CONTROL OF OPERATIONAL CHEMICALS AND OTHER SUBSTANCES

8.6(1) Issue: The controls for labelling and safe use of chemicals are not consistently implemented at the plant to ensure personnel and equipment safety

The team noted the following:

- Three employees did not use respirators and gloves when they worked on the door of Auxiliary building 404 using Toluene (a toxic substance). There were also many other persons in the area at the time. The chemical was in its original bottle which had the safety pictograms with the safety risk indicated.
- A chemical technician was observed in the canteen area with a chemical sampling holder and four bottles inside; this did not meet the expectations of the relevant chemical handling procedure.
- In the turbine hall a chemistry technician was observed with a 1.5 litre Polyethylene flask; this was not an approved chemical sampling bottle.
- In Reactor building room A301/1, next to the main circulating pump motor, a field worker was observed using Acetone (an irritant substance) without personal safety equipment. In addition, the bottle had a hand-written label with the name of the chemical, and no safety pictogram or approved category label.
- There was no emergency shower or eye wash in the Essential Service Water building where bulk chemicals were stored.
- In Unit 3 reactor hall one un-labelled Internally Bunded Container (IBC) was found filled with an unknown dark liquid. In addition, the IBC had an opening cut into the top of the container, exposing the liquid.
- Nine IBCs filled with caustic material were found in the Essential Service Water Building; there was no safety datasheet or location specifying where to find the required safety documentation.
- Caustic materials were stored in rooms 302 and 304 of Unit 3 auxiliary building; there was no chemistry material ‘category label’ available.
- In the turbine hall three workers were observed carrying bottled chemicals in buckets; the chemicals could cause skin irritation, but no chemical category labels were available.
- The following anomalies were observed in auxiliary building room 303;
  - Six chemical storage tanks were found without the required safety pictograms.
  - One sampling bottle was found with a hand written, corrected label.
  - One empty storage can (of approximately 10 litres) was found with two different chemical labels; this can cause confusion as to the contents of the container.
- Three radiochemical laboratories did not have eye wash facilities.

Without proper control of labelling and safe use of chemicals, the safety of personnel and equipment could be compromised.

Suggestion: The plant should consider improving its control for labelling and the safe use of chemicals to ensure safety of personnel and equipment.

IAEA Bases:

SSG-13

9.4. One or more lists of approved chemicals and other substances that are allowed to be used at the nuclear power plant should be made available. These lists should be well known by chemistry, maintenance and procurement staff and contractors.

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

9.10. When a chemical is transferred from a stock container to a smaller container, the latter should be labelled with the name of the chemicals, 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 the 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 check periodically.

9.12. Staff involved in receiving, storing, transporting and using chemical substances should be trained to understand storage compatibility, labelling requirements, handling, safety and impacts on structures, systems and components at the plant (see Section 8).

9.15. Chemicals should only be stored in an appropriate store that is fire protected and captures spillages and which is equipped with a safety shower, as required.

Oxidizing and reducing chemicals, flammable solvents and concentrated acid and alkali solutions should be stored separately. Tanks containing chemicals should be appropriately labelled. Reasonably small amounts of chemicals can be stored in other controlled environments in the workshops or operational department.

9. EMERGENCY PREPAREDNESS AND RESPONSE

9.2 EMERGENCY RESPONSE.

The team observed that the plant requirements and practices, in some aspects of emergency response, were not fully established to ensure an effective emergency response. A multiple unit accident exercise, involving 3 units, had not been performed. Some delays in emergency response occurred during an exercise. The emergency workers dose limits and dose alarms were too high and not in accordance with As Low As Reasonably Achievable (ALARA) principle. The team made a suggestion in this area.

The plant had developed and used a plant online Crisis Staff Decision Support Tool to support event classification and prognosis. It was intended for first responders of the Emergency Response Organization (Shift supervisors, Main Control Room, ECC, Monitoring group, Technical Support Centre, and others) to make prompt evaluation of emergency situations, prognoses for the classification of events, decisions and protective measures to mitigate the impact of events on-site and off-site. The team identified this as good performance.

9.3 EMERGENCY PREPAREDNESS

The team observed that some aspects of the plant emergency facilities and equipment were not always adequately maintained to support a comprehensive emergency response. Radiation instruments, communications equipment and assembly areas equipment were not always available in the required emergency response locations. For example, there were no contamination control instruments at the ECC entrance and the assembly areas in Units 3 and Unit 4 were not fully equipped. The team made a suggestion in this area.

Notification was made via fixed telecommunication network, mobile network and paging network. The system provided the transmission of information with the need to acknowledge by an identification code, thereby introducing automatic feedback into the notification system. The information was transmitted in the form of a voice message, text message, mobile phone, E-mail messages and pager messages. System configuration and management could also be done from a remote workplace. The pager communication infrastructure was independent of the public communication systems and covered an area of 20 km around the plant. The team identified this as good performance.

DETAILED EMERGENCY PLANNING AND PREPAREDNESS

9.2(1) Issue: The plant requirements and practices are not fully established to ensure the effectiveness of emergency response.

The team noted the following:

- A multiple unit accident exercise, involving 3 units, has not yet been performed to demonstrate that Emergency Control Centre (ECC) personnel can manage such an accident; this is planned for May 2020.
- During a firefighting drill in U3 room A116/1 on 27 November 2019, the fire brigade arrived promptly however, there were some delays in the response:
  - The Fire Brigade did not have a key to enter the room;
  - There was no clear requirement on who was responsible to open the door;
  - The Fire Brigade Captain assumed that the fire strategies for Unit 3 were still awaiting validation; he therefore utilized the strategy for Unit 1 and 2. Also, he did not have a room layout for the area including the locations of extinguishers and fire hoses. Furthermore, he did not know what volume of oil was in the room;
  - There were no clearly marked access ways for fire team access;
  - There was no visible escape route inside the controlled area.
- The plant evacuation arrangements in the emergency procedure Protective Measures for Unit 3 and 4, does not include detailed evacuation arrangements for the 3000 contractors working on Units 3 and 4.
- According to the document 'Radiation Monitoring during Emergency', Personal Alarming Dosimeters are set with the following alarms: Dose: 400/800 mSv, Dose Rate: 2000mSv/h. These alarms are set for the response team, fire fighters, medical personnel and external fire fighters. However, dose limits for all responders established between 500-1000 mSv are too high. These should be revised in accordance with ALARA principle.
- Emergency workers signed an agreement to be exposed to doses up to 500 mSv, the decision to receive doses up to 1000 mSv will be at the emergency workers discretion; this could challenge the plant's ability to resource the emergency response.
- During the emergency exercise held on 28 November 2019, response personnel inside the ECC did not wear dosimeters, such as passive dosimeters or PAD.
- It was unclear who is responsible, during out of normal working hours, for the habitability assessment during emergency situations, when the evacuation of ECC personnel and transfer to the backup ECC could be required.
- During the emergency exercise held on 28 November 2019, there was no one allocated to monitor the habitability of ECC, even though a gamma dose rate monitor was available the monitor remained switched off during the entire exercise.
- The generic criteria for doses for use as a target dose for the transition from an emergency response situation to an existing and planned exposure situation were not established.
- There was no timeframe specified within which to establish the shelters (Operational Support Centre) for Operational and Maintenance staff in the event of an emergency.

- In the case of an Alert, On-site Emergency, or Off-site Emergency being declared, site personnel were not required to muster at the gathering and sheltering points until these were established by the sheltering teams; thus, evacuation of the nonessential personnel would not start promptly.
- In procedure 'Facilities Emergency Measures' and in some training materials, there is no unique telephone number to report incidents. Instead the plant uses four different phone numbers for fires, chemical spills and medical incidents; stolen or broken radioactive sources; and for security incidents.

Without adequate requirements and practices for all aspects of the emergency response, the effectiveness of emergency response could be compromised.

Suggestion: The plant should consider improving its requirements and practices so that all aspects of the emergency response are effective.

IAEA Bases:

GSR Part 7
5.12. For facilities in categories I and II and for areas in category V, the notification point shall be able to initiate immediate communication with the authority that has been assigned the responsibility to decide on and to initiate precautionary urgent protective actions and urgent protective actions off the site (see also para. 5.7).
5.32. The operating organization of a facility in category I, II or III shall make arrangements to promptly assess and anticipate:
(a) Abnormal conditions at the facility;
(b) Exposures and radioactive releases and releases of other hazardous material;
(c) Radiological conditions on the site and, as appropriate, off the site;
(d) Any exposures or potential exposures of workers and emergency workers, the public and, as relevant, patients and helpers in an emergency.
5.33. These assessments as stated in para. 5.32 shall be used:
(a) For deciding on mitigatory actions to be taken by the operating personnel;
(b) As a basis for emergency classification (see para. 5.14);
(c) For deciding on protective actions and other response actions to be taken on the site, including those for the protection of workers and emergency workers;
(d) For deciding on protective actions and other response actions to be taken off the site;
(e) Where appropriate, to identify those individuals who could potentially have been exposed on the site at levels requiring appropriate medical attention in accordance with Appendix II.
5.34. These arrangements as stated in para. 5.32 shall include the use of pre-established operational criteria in accordance with the protection strategy (see para. 4.28(4)) and provision for access to instruments displaying or measuring those parameters that can readily be measured or observed in a nuclear or radiological emergency. In these arrangements, the expected response of instrumentation and of structures, systems and components at the facility under emergency conditions shall be taken into account.
5.38. For facilities in category I or II, arrangements shall be made for effectively making decisions on and taking urgent protective actions, early protective actions and other response actions off the site in order to achieve the goals of emergency response, on the basis of a graded approach and in accordance with the protection strategy. The arrangements shall be made with account taken of the uncertainties in and limitations of the information available when

protective actions and other response actions have to be taken to be effective, and shall include the following:
(a) The specification of off-site emergency planning zones and emergency planning distances for which arrangements shall be made at the preparedness stage for taking protective actions and other response actions effectively. These emergency planning zones and emergency planning distances shall be contiguous across national borders, where appropriate, and shall include:

(i) A precautionary action zone (PAZ), for facilities in category I, for which arrangements shall be made for taking urgent protective actions and other response actions, before any significant release of radioactive material occurs, on the basis of conditions at the facility (i.e. conditions leading to the declaration of a general emergency; see para. 5.14), in order to avoid or to minimize severe deterministic effects.

(ii) An urgent protective action planning zone (UPZ), for facilities in category I or II, for which arrangements shall be made to initiate urgent protective actions and other response actions, if possible before any significant release of radioactive material occurs, on the basis of conditions at the facility (i.e. conditions leading to the declaration of a general emergency; see para. 5.14), and after a release occurs, on the basis of monitoring and assessment of the radiological situation off the site, in order to reduce the risk of stochastic effects. Any such actions shall be taken in such a way as not to delay the implementation of precautionary urgent protective actions and other response actions within the precautionary action zone.

(iii) An extended planning distance (EPD) from the facility, for facilities in category I or II (beyond the urgent protective action planning zone), for which arrangements shall be made to conduct monitoring and assessment of the radiological situation off the site in order to identify areas, within a period of time that would allow the risk of stochastic effects in the areas to be effectively reduced by taking protective actions and other response actions within a day to a week or to a few weeks following a significant radioactive release.

(iv) An ingestion and commodities planning distance (ICPD) from the facility, for facilities in category I or II (beyond the extended planning distance), for which arrangements shall be made to take response actions (1) for protecting the food chain and water supply as well as for protecting commodities other than food from contamination following a significant radioactive release and (2) for protecting the public from the ingestion of food, milk and drinking water and from the use of commodities other than food with possible contamination following a significant radioactive release.

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

…..

(d) Evacuation plans;

…
Appendix I - GUIDANCE VALUES FOR RESTRICTING EXPOSURE OF EMERGENCY WORKERS
II.15. Generic criteria shall be established in terms of the projected dose for the implementation of protective actions and other actions aimed at enabling the termination of a nuclear or radiological emergency and the subsequent transition to an existing exposure situation with due consideration of, and verification of the fulfilment of, the conditions set out in para. II.16. These criteria are established as 1/5 of the generic criteria for the early protective actions and other response actions given in Table II.242 and are:
(a) An effective dose of 20 mSv per year;
(b) An equivalent dose to a fetus of 20 mSv for the full period of in utero development.
II.16. The decision to terminate the nuclear or radiological emergency and the subsequent transition to an existing exposure situation is to be taken after:
(a) Justified actions (see para. 4.29) have been taken to reach the generic criteria for enabling the transition to an existing exposure situation and it has been confirmed that any further actions to reach these criteria would do more harm than good;
(b) Confirmation that the source of exposure is fully characterized for all members of the public living as normal in the area;
(c) The situation with regard to exposure has been understood and has remained stable;
(d) Any restrictions on normal living conditions are limited and provisions are in place to confirm compliance with such restrictions;
(e) Confirmation that interested parties, including the public, have been consulted and are being kept informed about the basis for the adjustment of emergency response actions and for the transition, with the associated health hazards put into perspective (see para. 5.72).

GSR Part 4 Rev. 1
2.6(f) Principle 9 on emergency preparedness and response: to identify the full range of foreseeable events for which arrangements for emergency preparedness and response need to be considered.

SSR-2/2 Rev. 1
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
4.28. Emergencies have occurred in facilities in treat categories I, II and III that have resulted in hazardous conditions on the site.
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, fisherman).
Table 10 – CLASS DESCRIPTION FOR EMERGENCIES AT FACILITIES

GSG-11
4.60. After termination of the emergency and transition to an existing exposure situation, the reference level for the residual dose in an existing exposure situation should be applied in the

range of 1 to 20 mSv per year, as required by GSR Part 3 [3] (see Table 1). The International Commission on Radiological Protection recommends that the reference level for the optimization of the protection strategy is selected from the lower end of the 1–20 mSv per year range as a long term objective for existing exposure situations (see Ref. [29]). Further guidance can be found in WS-G-3.1 [16] and GSG-8 [17].

9.3 EMERGENCY PREPAREDNESS

9.3(1) Issue: Some aspects of the emergency facilities and equipment are not always adequately maintained or available to support a comprehensive emergency response.

The team noted the following:

– At the entrance in the Emergency Control Centre (ECC) there were no instruments for measurement of contamination, also there was no change of clothes available in case the shelter team became contaminated (contamination instrumentation and clothes were located inside the Emergency Control Centre; this assumed the best case scenario, that the shelter team would not be contaminated when they arrive in the ECC).

– The Back-up ECC was not provided with fixed or mobile radio communication stations.

– Not all cable penetrations were sealed within the ECC. Cable routes in some areas were not protected.

– The shower within the shelter had just a hose, without a shower head, and was located at the opposite end of the shelter to the main access. This could result in potentially contaminated people returning from the field being required to travel the length of the shelter to reach the shower. Even thought there was an arrangement to isolate any contamination, there was still a risk of spreading contamination within the shelter.

– A gamma dose rate monitor in the assembly area of Unit 3 Reactor Building Corridor did not have a calibration label. Also, there was no contamination monitor. Furthermore, the device to communicate to large numbers of people was not stored in the assembly area, instead, it was stored in office. This was required to transmit messages to approximately 1400 assembled personnel.

– The assembly area at U4 Turbine Building Hall did not have a gamma dose rate monitor, also there was no contamination monitor. Furthermore, the device to communicate to large numbers of people was not stored in the assembly area, instead, it was stored in an office. This was required to transmit messages to approximately 800 assembled personnel.

– In both assembly areas (Unit 3 Reactor Building Corridor and Unit 4 Turbine Building Hall) there were procedures for Assembly Area Teams, but these were not authorized and did not have a revision number or revision date written on them.

– Iodine and particulate filters used for monitoring air contamination inside the ECC did not have expiry dates written on them.

– A filter for a full-face mask with an expiry date on October 2014 was found in the environmental monitoring mobile laboratory.

Without adequate emergency facilities and equipment, the effectiveness of emergency response could be compromised.

Suggestion: The plant should consider improving the maintenance and availability of emergency facilities and equipment to ensure the effectiveness of emergency response.

IAEA Bases:

GSR Part 7

5.41. The operating organization of a facility in category I, II or III shall make arrangements to ensure protection and safety for all persons on the site in a nuclear or radiological emergency. These shall include arrangements to do the following:

(a) To notify all persons on the site of an emergency on the site;

(b) For all persons on the site to take appropriate actions immediately upon notification of an emergency;

(c) To account for those persons on the site and to locate and recover those persons unaccounted for;

(d) To provide immediate first aid;

(e) To take urgent protective actions.

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

(a) Suitable assembly points, provided with continuous radiation monitoring;

(b) A sufficient number of suitable escape routes;

(c) Suitable and reliable alarm systems and other means for warning and instructing all persons present under the full range of emergency conditions.

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.

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

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

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

6.37. The operating organization and response organizations shall establish and maintain adequate records in relation to both emergency arrangements and the response to a nuclear or radiological emergency, to include dose assessments, results of monitoring and inventory of radioactive waste managed, in order to allow for their review and evaluation. These records shall also provide for the identification of those persons requiring longer term medical actions, as necessary, and shall provide for the long term management of radioactive waste.

6.38. The operating organization and response organizations shall make arrangements to review and evaluate responses in actual events and in exercises, in order to record the areas in which improvements are necessary and to ensure that the necessary improvements are made (see Requirement 19).

10. ACCIDENT MANAGEMENT

10.1. ORGANIZATION AND FUNCTIONS

The Plant had taken an approach on Unit 3 to define severe accidents as Design Extension Conditions (DEC). Thus, the control of severe accidents had been included within the plant's design domain. The 'Original Design' of Unit 3 was established when construction first started in 1986. In the early 1990s construction was halted for many years. When the decision was made to restart the construction, the new Basic Design was accepted in 2008 and included numerous major modifications to the Original Design. The stress tests led to additions to the basic design such as enhancements to the management of simultaneous severe accidents in multiple units. The team recognized the chosen SAM approach as good performance.

The Plant had analysed the sufficiency and organization of the operation shift personnel to carry out all foreseen SAM actions during emergencies, so that an effective transition from the regular functional responsibilities to all preventive and mitigatory SAM actions could be completed without the need for additional external support during the first 24 hours of an accident. The staff had received training on performing these new activities, which covered all operational modes and initiating events. The team recognized this as good performance.

10.4. DEVELOPMENT OF PROCEDURES AND GUIDELINES

The team noted that the plant had not assessed accessibility of all locations for the local SAM actions during emergencies. The team also noted that the SAM Guideline on Injection to the Reactor Coolant System did not consider a potential long-term adverse effect of massive coolant injection in the late phase of a severe accident on the molten corium pool. The team made a suggestion in this area.

10.8. USE OF PSA, PSR AND OEF

The plant had implemented an additional signal for automatic actuation of the low-pressure safety injection (LPSI) during refuelling outages, when the reactor pressure vessel (RPV) is open. The automatic actuation was based on the RPV level measurement and could ensure refilling of the open reactor, when LPSI pumps could be unavailable due to maintenance. The modification led to a significant decrease of the core damage frequency during shutdown states. The team recognized this as good practice.

DETAILED ACCIDENT MANAGEMENT FINDINGS

10.4. DEVELOPMENT OF PROCEDURES AND GUIDELINES

10.4(1) Issue: The plant has not sufficiently addressed some weaknesses in severe accident management guidance.

The team noted the following:

- The plant has not assessed accessibility of all locations for local severe accident management (SAM) actions during accident conditions.
- The Severe Accident Management Guideline on Injection to Reactor Coolant System did not consider a potential long-term adverse effect of massive coolant injection in the late phase of a severe accident, when there is a fully developed molten corium pool on the lower head of the reactor vessel. A potential energetic interaction of the upper molten metal layer with the injected coolant could jeopardize the In-Vessel Retention strategy by overloading the remaining thinned vessel wall.

Without assessing the accessibility for local SAM actions and without considering all negative impacts, the mitigation strategies might not be fully effective.

Suggestion: The plant should consider improving its severe accident management programme by assessing the accessibility of the locations for local actions and the potential adverse effects of coolant injection on the molten corium pool.

IAEA Bases:

SSR-2/2 (Rev. 1)
5.8F. In developing the accident management programme and its procedures, the possibility of regional infrastructure being degraded and of adverse working conditions (e.g. elevated radiation levels, elevated temperatures, lack of lighting, limited access to the plant from off the site) for operators, as well as the possibility of operating conditions for equipment being degraded, shall be taken into account so as to ensure that actions expected for accident management will be feasible and will be able to be taken in a timely and reliable manner.

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3.51. In the development of severe accident management guidance, account should be taken of the habitability, operability and accessibility of the main control room and the technical support centre. The accessibility of other relevant areas, such as areas for local actions, should also be assessed and taken into account in the development of severe accident management guidance. It should be investigated whether expected dose rates and other environmental conditions may give rise to a need for restrictions on personnel access to such areas; if this is found to be the case, appropriate measures should be considered.

3.52 The ability of plant personnel to successfully take unconventional measures to mitigate accident challenges under adverse environmental conditions should be carefully considered. When necessary, personal protective equipment (e.g. protective clothing, breathing equipment) should be provided for the execution of such tasks. Personnel may need to conduct the assigned tasks in hazardous conditions, and procedures and instructions associated with such actions and with the radiation protection of staff should be developed (see SSR-2/1 (Rev. 1) [3], GSR Part 7

[7] and IAEA Safety Standards Series No. GSR Part 3, Radiation Protection and Safety of Radioactive Sources: International Basic Safety Standards [25]).

3.23. A systematic evaluation of the possible severe accident management strategies should be conducted to confirm their feasibility and effectiveness, to determine potential negative impacts and to prioritize the strategies using appropriate methods. Adverse conditions that may affect the execution of a strategy during the evolution of a severe accident should be considered. The evaluation should be documented in the relevant background document.

3.24. Particular consideration should be given to severe accident management strategies that have both positive and negative impacts in order to provide a basis for a decision as to which strategies constitute a proper response for a given plant damage state. The background documentation supporting SAMGs should include a full description of the benefits and potential negative implications of the severe accident management strategies.

10.8. USE OF PSA, PSR AND OEF

10.8(a) Good practice: Implementation of an automatic actuation of low pressure safety injection in shutdown states.

To reduce the core damage frequency (CDF) in reactor shutdown states the plant had implemented an additional signal for automatic actuation of the low-pressure safety injection (LPSI) during refuelling outages, when the reactor vessel is open.

The main features of the additional LPSI actuation are the following:

– The actuation is based on the level measurement in the reactor pressure vessel (RPV),

– The actuation occurs automatically without any manual action,

– Due to high LPSI flow rate, actuation of individual LPSI pumps is performed gradually ensuring that at any given time only one pump will be in operation,

– Alarms are included to alert maintenance crews and other personnel to evacuate from the reactor flange area before LPSI actuation,

– The cessation of injection when the required RPV water level was reached.

The actuation would become functional after manual connection of RPV level measurement, when the reactor is open. An automatic warning signal was actuated when the level in the RPV drops to 10.8 m in order to allow personnel working on the main reactor flange to leave this area. The LPSI automatic start for each train is done from the level values 10.4; 10.3 and 10.2, respectively. After restoring the level in the reactor to 11.6 m, the valve on the discharge line will be automatically closed and the pump runs in recirculation mode. The pump would be shut off by the operator.

The modification ensured automatic refilling of coolant into the open reactor and would avoid the potential for a human error, which could lead to the inability to ensure the reactor core is kept covered with water. It also could prevent the RPV overfilling. Once implemented this modification will lead to a significant decrease in the shutdown state CDF.

11. HUMAN TECHNOLOGY AND ORGANIZATION INTERACTION

11.1. INTERFACES AND RELATIONSHIPS

The Plant had adopted an effective way of interfacing with external organizations and interested parties, in particular with young people, which could contribute to a citizenry knowledgeable about the contribution of nuclear to the electricity mix and support the development of future workers for the industry. The Plant had invited young people from universities across Slovakia to the award-winning Visitors' Energoland Centre to participate in an annual job fair and learn more about nuclear technology. The Plant proactively undertook outreach activities to communicate facts about nuclear power and partnered in an innovative way with a Slovak Film Festival to reach over 15,000 young people with a message about Climate Change. The team identified this as good performance.

11.2. HUMAN FACTORS MANAGEMENT

The team identified that the Human Performance Programme was not comprehensive nor rigorously implemented to ensure that human errors were minimized and events prevented. The Human Performance Improvement Programme did not apply to the entire plant, and there were missed opportunities to share lessons learned between the operating part of the plant and the construction project. Inconsistent use of human performance tools contributed to several events in 2018 and 2019. The team made a recommendation in this area.

11.4. SAFETY CULTURE

The team identified that the plant conducted a biennial survey of safety culture which did not include contractors. The scope of the last assessment was modified to include working climate, and as a result, the survey framework was altered to reduce the number of questions related to nuclear safety. These could have reduced the effectiveness of the nuclear safety aspects of the assessment. The team encouraged the plant to communicate with the corporate organization to improve in this area.

DETAILED HUMAN TECHNOLOGY AND ORGANIZATION INTERACTION

11.2 HUMAN FACTORS MANAGEMENT

11.2(1) Issue: The Human Performance Programme is not comprehensive and rigorously implemented across the organization to ensure human errors are minimized and events prevented.

The Team noted the following:

– Use of human error prevention tools and related events:

Pre-Job Brief:

- On 22 November 2019, during a planned alignment on Unit 3, an event led to an unplanned power loss and failure in the 6kV electrical distribution equipment for severe accident management on Unit 1s and 2. The preliminary investigation revealed that only an informal pre-job brief had been conducted with the staff involved, and no formal checklist was used. The risk of affecting the neighbouring unit was not identified and addressed during the informal pre-job brief. Contributing to this event was the lack of a suitable procedure to perform the evolution with reference to relevant operating experience.
- There was no Human Performance Tool included in the pre-job brief for specific Radiation Protection tasks inside the controlled area. In addition, during observations of pre-job briefs, no coaching was given to the workers regarding the use of Human Performance Tools and Operating Experience.

Self-Check:

- During Unit 1 and 2 shift crew Simulator training, a new Turbine Operator (TO) opened the condenser water flow control valve without using self-check.
- On 16 January 2019, an event occurred when an operator was preparing to lock out the low-pressure Emergency Core Cooling System pump 3JNG61AP001 and was interrupted by an electrician with a phone call. He subsequently locked out the wrong, adjacent terminal for Essential Service Water pump 3PEC03AP003 without proper self-check.

3-Way Communication:

- During a Training simulator observation, there was no consistent use of 3-Way Communication, nor was there any use of the Phonetic Alphabet by Unit Supervisor and Operators when using telephone or radio.
- On 12 October 2018, a repeat event occurred during testing of the fire suppression system of the 110kV reserve supply transformer, when the worker conducting the test communicated remotely with the unit supervisor and incorrectly proceeded without clear instructions, and without using 3-way communication. The fire suppression system was wrongly actuated as a result.

- The plant's application of the Human Performance Improvement Programme was inconsistent:
  - Units 3 and 4 did not participate in the Corporate Human Performance Improvement Peer Group as the programme does not apply to them.

- The plant does not expect Contractors to implement a Human Performance Programme:
  - Units 3 and 4 Quality Management System requirements related to some aspects of Human Performance Tools (questioning attitude, pre-job briefing, verification of work) are required but there was no comprehensive application of human error reduction techniques applied to the Unit 3/4 project contractors.
  - Contractors on Unit 3/4 did not receive Human Performance Tool training
  - An e-learning module for Nuclear Safety and Human Performance was planned for implementation at Unit 3 and 4 in early 2020, but no workers and contractors had been scheduled to attend the training, and there was no agreement on the requirements for subcontractors to complete the training.
- The plant does not consistently communicate Human Performance trends, results or focus areas to drive results:
  - The annual Units 3 and 4 Construction and Units 3 and 4 Commissioning report of Events and Corrective Actions did not identify Human Performance related aspects from any event.
  - Units 3 and 4 did not analyse events using the Units 1 and 2 Quick Analysis for Human Factors or have a traffic light system to identify when a Human Performance event had occurred. Such events were not systematically shared with Units 1 and 2, resulting in potential repeat events.
  - During the opening presentations for a shift operations crew training meeting several days after an operation human performance event, managers did not communicate any information or lessons regarding the event to the operations shift crew.
  - There were few visible indicators of plant performance prominently displayed in the field, related to Human Performance or other Key Performance Indicators.
  - The plant used general rather than specific statements when identifying planned improvement: 'Improve the use of the Human Error Prevention tools', and 'implement high standards on Units 1 and 2 and also on Unit 3 when operating'.
  - The annual Unit 1 and 2 Human Performance Report did not include an analysis of which human error had contributed most significantly to events.

Without a comprehensive Human Performance Programme rigorously implemented throughout the organization, the risk of human error can increase.

Recommendation: The plant should improve the Human Performance Programme and its implementation throughout the organization to ensure human error related events are minimized.

IAEA Bases:

GSR Part 2
Requirement 6: Integration of the management system.
The management system shall integrate its elements, including safety, health, environmental, security, quality, human-and-organizational-factor, societal and economic elements, so that safety is not compromised.
4.24. Competences to be sustained in-house by the organization shall include: competences for leadership at all management levels; competences for fostering and sustaining a strong safety culture; and expertise to understand technical, human and organizational aspects relating to the facility or the activity in order to ensure safety.
4.33. The organization shall retain responsibility for safety when contracting out any processes and when receiving any item, product or service in the supply chain.
4.36. The organization shall make arrangements for ensuring that suppliers of items, products and services important to safety adhere to safety requirements and meet the organization's expectations of safe conduct in their delivery.
5.2. Senior managers and all other managers shall advocate and support the following:
(d) The reporting of problems relating to technical, human and organizational factors and reporting of any deficiencies in structures, systems and components to avoid degradation of safety, including the timely acknowledgement of, and reporting back of, actions taken;
(f) The means by which the organization seeks to enhance safety and to foster and sustain a strong safety culture, and using a systemic approach (i.e. an approach relating to the system as a whole in which the interactions between technical, human and organizational factors are duly considered)

SSR 2/2 (Rev1)
3.1 The prime responsibility for safety shall be assigned to the operating organization of the nuclear power plant. This prime responsibility shall cover all the activities relating to the operation directly and indirectly. It includes the responsibility for supervising the activities of all other related groups, such as designers, suppliers, manufacturers and constructors, employers and contractors, as well as the responsibility for operation of nuclear power plant(s) by the operating organization itself. The operating organization shall discharge this responsibility in accordance with its management system.

GS-G-3.5
2.32. All safety barriers are designed, constructed, strengthened, breached or eroded by the action or inaction of individuals. Human factors in the organization are critical for safe operation and they should not be separated from technical aspects. Ultimately, safety results from the interaction of individuals with technology and with the organization.
2.33. The concept of safety culture embraces this integration of individuals and technical aspects...
2.34. In a strong safety culture, there should be a knowledge and understanding of human behaviour mechanisms and established human factor principles should be applied to ensure the outcomes for safety of individuals–technology–organization interactions…

2.36. When analysing events, consideration should be given to the possible influence of all these factors on human behaviour. These factors should also be considered when the purpose is to identify potential weaknesses in the interactions between individuals–technology–organization and to determine how to strengthen barriers or introduce new barriers to prevent human error. Ideally, interdisciplinary teams should carry out predictive and preventive analyses of these types of event. Such teams should include human behaviour competence, so as to analyse the individuals–technology–organization interactions from different perspectives in order to identify suitable barrier functions.
2.37. Individuals should also be trained in how to recognize situations that are likely to give rise to errors, so that they can avoid making mistakes. In addition, there are various activities that could be carried out on an individual basis to prevent error. Among these are:
(a) Pre-job briefings, asking the questions: What are the critical steps? What situations associated with the work assignment are likely to give rise to errors? What defences are in place to prevent events?
(b) Self-checks applying the stop–think–act–review (STAR) concept.
(c) Peer checks — having a second individual check the intended action prior to carrying it out.
(d) Three-way communication by which a message is communicated from one individual to another. The individual receiving the message repeats the message to confirm a clear understanding and the originator acknowledges that the message has been correctly understood and so closes the communication loop.
(e) Conservative decision making should be applied when there are no procedures in place or plans made for the activity.
4.7. When contracts are awarded for work to be carried out at the installation by individuals from other organizations, the organization should ensure that there is no conflict between the work practices and standards of the supplier and those at the installation.

NS-G-2.6
3.8. Contractors should be subject to the same standards as plant staff, particularly in the areas of professional competence, adherence to procedures and evaluation of performance. Suitable steps should be taken to ensure that contractors conform to the technical standards and the safety culture of the operating organization.

NS-G-2.14
4.27. Pre-job briefings should be used as a means of avoiding personnel errors, difficulties in communication and misunderstandings.
4.45. In communications, the full description of any plant item should be given and the phonetic alphabet should be used where appropriate. To reduce the likelihood of error in verbal communication, both in the plant and in control rooms, training should be provided in the use of three way communications between the sender and recipient and this method should be used as widely as practicable, especially in abnormal situations.

NS-G-2.14
4.27. Pre-job briefings should be used as a means of avoiding personnel errors, difficulties in communication and misunderstandings. The operations shift crew should use pre-job briefings for all operations other than daily, routine shift activities…

4.46. Recipients of verbal instructions should proceed only when they fully understand the task to be undertaken. Where appropriate, they should check that the action that they have taken delivers the expected results.
4.47. When verbal or written instructions or orders are used in operational practice at a plant, administrative procedures should be put in place to ensure that the verbal or written orders do not diverge from the established procedures and do not compromise established operational limits and conditions.

13. COMMISSIONING

13.2. ORGANIZATION AND MANAGEMENT OF COMMISSIONING

The plant had not fully developed and implemented an integrated and strategic approach to commissioning that ensures that associated potential risks were properly identified, assessed and addressed in a conservative and holistic manner to support safe commissioning of the plant. The team noted gaps in performance with: integration and scheduling of activities; strategic management of risks; change management planning and staff readiness; resource coordination and training; and plant configuration and documentation. The team noted that the history of multiple delays on Unit 3 contributed to a 'wait and see' mindset and that non-technical activities such as employee communication and Independent Nuclear Oversight activities were not linked to the Unit 3 schedule. The team made a recommendation in this area.

The team observed that the preparation of commissioning activities and the interface between Commissioning and Operations were not always properly controlled and coordinated to ensure safety of commissioning activities. This resulted in events, unexpected water spills and rework. Temporary Operating Instructions prepared by Commissioning were not always adequately written to ensure safe execution of activities. The team made a recommendation in this area.

DETAILED COMMISSIONING FINDINGS

13.2. ORGANIZATION AND MANAGEMENT OF COMMISSIONING

13.2(1) Issue: The plant has not fully developed and implemented an integrated and strategic approach to ensure that associated potential risks are properly identified, assessed and addressed in a conservative and holistic manner to support safe commissioning of the plant.

The team noted the following:

Integration and Scheduling of Activities

- The non-active testing schedule and the draft commissioning schedule did not include links to non-technical activities such as changes to resource requirements, training, employee communications and changes in expectations or expected behaviours of workers.
- There was no visible high-level schedule for the project milestones or achievements to align staff around transition. There were no visible project management or nuclear safety posters or visual displays in the plant.
- The schedule from fuel loading onwards had been drafted but did not have defined activity dates since the fuel load date had not been finalized. The schedule still required some alteration to adapt to the changes made in non-active testing such as primary system containing water with Boric Acid instead of demineralized water during heat up.

Preparation and Arrangement of Activity Details

- On 27 November 2019, while executing a transfer of water with 2g/l Boric Acid from a Low-Pressure Emergency Storage tank to a Makeup and Let-down tank, about 4 cubic meters of water was inadvertently directed to the floor of Room A001/1 through open drain valves on the suction to the spray pumps. A procedure was used to perform the transfer activity which did not include steps to confirm the correct alignment of these drain valves. A procedure to properly align the system prior to the transfer was available but was not used.
- During a daily review meeting for the work in the schedule for the next day, only the chair of the meeting and the scheduler had a copy of the schedule, all the other participants used their personal notes. There were several items discussed that required significant coordination and had not been planned in a manner that considered the overall consequences of the alignments. These included determining which way to align the steam system to address planned reduction of non-essential service water pump availability which was due to take place the following day.

Strategic Management of Risks

- There was no pre-defined plan for Independent Nuclear Oversight activities linked to the activities in the non-active testing and commissioning schedule. Oversight on Unit 3 was done in an ad hoc manner because there was no stable schedule for work activities.
- A previous Independent Nuclear Oversight escalation of Foreign Material Exclusion (FME) in the plant, initiated on 10 July 2017, was not applied to Unit 3 because it was not yet in operation. Independent Nuclear Oversight raised FME concerns for Unit 3 in an ongoing manner in monthly reports as early as 2013.

- Non-technical risks related to potential future challenges to the non-active testing and commissioning programme were not captured in a comprehensive manner that showed the risks, potential consequences and mitigation strategies.
- The process for management of project risks was focussed on project scope, cost and technical risks, not risks associated with people and processes for transition to operation.
- During interviews, some managers were not able to articulate risks associated with the readiness of people for the transition to operations and most of their focus was on technical aspects.
- No comprehensive self-assessment or audit of readiness was completed to assess the risk and potential consequences of the transition to operation on people or processes.
- The follow up to the safety system error handling logic events that occurred during the previous hot functional test did not result in clear identification of the root cause of the event and the actions needed to prevent recurrence. Plant procedures were not revised to specify the need to perform an architecture level review of changes to hardware and software in control systems to prevent similar events from occurring in future modifications.

Change Management Planning and Staff Readiness

The history of multiple delays on Unit 3 contributed to a ‘wait and see’ mind-set amongst leaders and staff.

- Leaders did not exhibit a strong sense of risk awareness around readiness for transition to operations
- Leaders expressed low confidence in meeting the planned fuel load date.
- The plant was not aligned around the planned fuel load date, key milestones, and the readiness criteria associated with all major processes and functional areas.

Upcoming changes that will affect required behaviours through the non-active testing and commissioning stages, such as personnel access routes, were not planned in a strategic manner. No specific change management plans were prepared for some of these changes.

There was no documented change management plan or communication plan related to effects of the transition to operation on people or processes. The plant did not proactively engage the communications group to prepare messaging around aspects of transition from commissioning to operations that will affect staff.

Resource Coordination and Training

- The plant could be challenged to effectively respond to maintenance needs once Unit 3 is placed in service, given the current situation of increasing maintenance backlogs in Units 1 and 2.
- A concern was raised during a daily planning meeting that chemistry training of the commissioning team was required prior to charging the boric acid system tanks planned to take place several days later.
- The adherence to on-time improvement action completion in the technical area was 50% for a week in November 2019. A manager indicated that this was due to conflicts with support of Unit 3 activities.

- The Unit 3 and 4 simulator was currently unavailable for just in time training in preparation for plant alignment activities.

Plant Configuration and Documentation

- Workers and supervisors identified that Unit 3 work was sometimes challenged due to documentation that was not completed or updated in a timely manner. This includes 'as tested' documentation not matching the physical plant, primarily in the conventional island section of the plant.
- It was found that the excitation voltage for Mobile Diesel Generators (required to be available for Unit 3 Initial Fuel Load) did not match the design value. These devices had already been tested in preparation for turnover.
- During a non-conformance report screening meeting, Operations personnel identified a concern with the potential for power loss to certain switchgear resulting in an unacceptable effect on operations. A decision was made at the meeting that resolution could be deferred until the unit was in operation as there was no time to solve the issue at this stage. This could challenge the organization to resolve issues in a quality manner without schedule impact.
- Water used for flushing Unit 4 equipment was directed through drainage to the Unit 3 collection system which was being used to handle water from the primary circuit. This had a direct effect on the control of tank water levels and contents, including management of chemical concentration and impurities. This collection system for Unit 3 had not been turned over to operations.

Plant Events:

- Four repeat events occurred since August 2019 which resulted in activation of safety systems with uncontrolled equipment starts and pressurizing of primary circuit.:
- Prior to the first heat up of the unit, a list of incomplete items for Heating, Ventilation and Air Conditioning (HVAC) civil equipment was reviewed and it was considered that the outstanding items would not affect the system for heat up. During heat up of the unit, temperatures exceeded expected values in the hermetic zone, and this resulted in cable damage in that area.
- Damage to cooling towers of Unit 3 occurred during operation of circulation water pumps due to not addressing a previously known issue from experience on Units 1 and 2.
- A repeated event occurred in November 2019, resulting in unplanned loss of electrical power to equipment.

Without developing and implementing an integrated and strategic approach in a conservative and holistic manner, where risks, including personnel and process readiness risks, are properly identified, assessed and addressed, safe commissioning of the plant could be challenged.

Recommendation: The plant should develop and implement an integrated and strategic approach to ensure that associated and potential risks are properly identified, assessed and addressed in a conservative and holistic manner to support the safe commissioning of the plant.

IAEA Bases:

SSR-2/2 (Rev. 1)

6.8. All the functions of the operating organization shall be performed at the appropriate stages during commissioning. These functions shall include discharging responsibilities for management, training of personnel, the radiation protection programme, waste management, managements of records, fire safety, physical protection and the emergency plan.

6.10. From the commencement of commissioning, reviewed and approved arrangements for work control, modification control and plant configuration control shall be in place to meet the conditions of the commissioning tests.
6.12. The operating organization shall ensure that the interfaces and the communication lines between different groups (i.e. groups for design, groups for construction, contractors, groups for commissioning and groups for operations) shall be clearly specified and controlled.

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2.14. The commissioning programme should provide a framework for the scheduling of tests and related activities, and for suitable personnel and equipment to be available at the proper time. The programme should also provide for the timely production of all documentation.
2.29. For multi-unit plants, the following provisions should be applied:

(c) Special provisions, including provision for adequate communication, should be made to ensure that the safety of a unit already in operation is not jeopardized in the commissioning tests for another unit. Such special provisions should include conducting a risk assessment.
2.34. The operating organization, as the licensee for operation of the plant, bears the overall responsibility for nuclear and radiation safety as well as for protection of workers and the environment, and should ensure the correct and satisfactory organization, planning, execution and assessment of the commissioning process.

2.35. Appropriate organizational arrangements should be established to ensure that the operating organization can properly and effectively discharge its responsibilities with regard to the commissioning programme. When commissioning activities are conducted by contractors, the operating organization should make the necessary arrangements to review and approve these activities at all stages, and it should establish appropriate hold points and milestones.
3.3. The operating organization (licensee) should develop and implement a management system that describes the overall arrangements for the management, performance and assessment of activities at the nuclear power plant during commissioning. The management system should cover all the activities that are carried out in, or are necessary for, the commissioning stage.

3.11. The operating organization should ensure that appropriate procedures are established for the control of commissioning activities on the site, to ensure that the commissioning of the plant fulfils the requirements of the commissioning programme.

3.12. Arrangements should be made for adequate and, where necessary, independent oversight and control of the quality of ongoing work.

3.59. Resources necessary to carry out the commissioning activities, such as tools, and utilities and logistics should be planned for.

5.15. All commissioning activities should be performed in accordance with approved written procedures. The preparation of test procedures, including their verification and approval, should be specified in the management system of the operating organization. The level of review should reflect the importance to safety of the system or component and the nature of the test. The procedures that are established should provide for timely reporting to allow commissioning to proceed safely and efficiently.

13.2(2) Issue: Preparation of Commissioning activities and Interface between Commissioning and Operations are not always properly controlled and coordinated to ensure safety of commissioning activities.

The team noted the following:

- During a commissioning surveillance test an unexpected actuation of an Engineered Safety Features Actuation System (ESFAS) resulted in the actuation of the emergency power supply for steam generators. The apparent causes identified were: missing procedures to describe how to perform this test; and potential risks not being identified.
- On 27 November 2019, during commissioning of Mobile Diesel 4XKZ55, an additional test was being conducted, which involved the Operations Department by means of Temporary Operating Instruction (TOI). The following deviations were observed:
  - The TOI was not validated by Operations Department.
  - There was a handwritten modification without quality control in changing 3XKZ55 to 4XKZ55.
  - There were no clear requirements on actions to be implemented by the Operator. For example, the procedure required that transformer 3BMT51 be switched off without giving the exact code of the breaker to operate. Consequently, it was not possible to implement self-check and this created possible confusion about the breaker.
  - The TOI requested at step 4 to start Boric Acid Concentrate pump 3KDD11AP001, but it was discovered during the Pre-Job Briefing that this pump could not be started because both upstream boric acid tanks (3KDD10/15BB01) were empty. This was not detected during the pre-job preparation.
  - The previous point led to the postponement of the Commissioning test to the following day and a change to the shift crew priority. Operations had to switch to Boric Acid Tank filling for the purpose of this test without a prepared procedure.
- On 27 November 2019, while aligning the Oil Cooler system for the main pumps on the Makeup and Letdown system, the cooling water inlet main valve was left open during the draining activity resulting in overfilling of the non-active side of the collection tank and 5 cubic meters of water on the floor of Room A0004/1. No procedure was used to perform the alignment.
- A procedure for commissioning activities associated with 6kV transformer 3BBC was attached as part of the daily plan. This procedure did not document the names or signatures of the preparer, reviewers or the approval authority.
- In the TOI dealing with pipe pressurization during Hot Hydro Test, several actions were described. However, in initial conditions, it was described that activities would be implemented by Contractor and by Operations, but it was not possible to state which action would be done by the Operations Department.
- Only several days before mixing boric acid for Unit 3, a decision was made to reduce the initial boric acid concentration from 5 g/l to 2 g/l in order to prevent boric acid crystallization during the extended operation in hot conditions following the second heat up of the unit.

– In specific monitoring actions required by Commissioning on Auxiliary Cooling Water Pump 8 PCC, there was no clear requirement about which sensor to monitor.

Without adequate preparation and control of Commissioning activities and proper interface and coordination between Commissioning and Operations, the safety of Commissioning activities cannot be ensured.

Recommendation: The Plant should improve its preparation and control of Commissioning activities, interface and coordination between Commissioning and Operations to ensure the safety of Commissioning activities.

IAEA Basis:

SSR-2/2 (Rev 1)
6.9 Operating procedures and test procedures shall be verified to ensure their technical accuracy and shall be validated to ensure their usability with the installed equipment and control systems. Verification and validation of procedures shall be performed to confirm their applicability and quality, and to the extent possible shall be performed prior to fuel handling operations on the site. This process shall continue during the commissioning phase. Verification and validation shall also be carried out for procedures for overall operation.

6.12 The operating organization shall ensure that the interfaces and the communication lines between different groups (i.e. groups for design, groups for construction, contractors, groups for commissioning and groups for operations) shall be clearly specified and controlled.
6.14 During construction and commissioning, the plant shall be monitored, preserved and maintained so as to protect plant equipment, to support the testing stage and to maintain consistency with the safety analysis report.

7.1 The level of detail for a particular procedure shall be appropriate for the purpose of that procedure. The guidance provided in the procedures shall be clear and concise and, to the extent possible, it shall be verified and validated. The procedures and reference material shall be clearly identified and shall be readily accessible in the control room and in other operating locations if necessary. They shall be made available to the regulatory body, as required. Strict adherence to written operating procedures shall be an essential element of safety policy at the plant.

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3.36. Many other activities are performed in parallel with the commissioning of the plant, such as activities relating to construction, operation and maintenance.

3.37. The interface between these activities should be adequately managed to ensure the safety of the plant and the protection of personnel, and to allow for an adequate Commissioning programme.

3.38. The interrelationships between tests, between systems and between units on the same site should be considered.

DEFINITIONS

DEFINITIONS – OSART MISSION

Recommendation

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

Suggestion

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

Good practice

A good practice is an outstanding and proven programme, activity or equipment in use that contributes directly or indirectly to operational safety and sustained good performance. A good practice is markedly superior to that observed elsewhere, not just the fulfilment of current requirements or expectations. It should be superior enough and have broad enough application to be brought to the attention of other nuclear power plants and be worthy of their consideration in the general drive for excellence. A good practice is novel; has a proven benefit; is replicable (it can be used at other plants); and does not contradict an issue. Normally, good practices are brought to the attention of the team on the initiative of the plant.

LIST OF IAEA REFERENCES (BASIS)

SF-1 Fundamental Safety Principles (Safety Fundamentals)

GSR-1 Governmental, Legal and Regulatory Framework for Safety (General Safety Requirements)

GSR-2 Preparedness and Response for a Nuclear or Radiological Emergency (Safety Requirements)

GSR Part 2 Leadership and Management for Safety

GSR-3 The Management System for Facilities and Activities (Safety Requirements)

GSR Part 3 Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, Interim Edition

GSR-4 Safety Assessment for Facilities and Activities (General Safety Requirements 2009)

GSR-5 Predisposal Management of Radioactive Waste (General Safety Requirements)

GSR Part 7 Preparedness and Response for Nuclear or Radiological Emergencies

GSG-1 Classification of Radioactive Waste (Safety Guide 2009)

GSG-2 Criteria for Use in Preparedness and Response for a Nuclear and Radiological Emergency

GSG-2.1 Arrangement for Preparedness for a Nuclear or Radiological Emergency (Safety Guide)

GSG-3.1 Application of the Management System for Facilities and Activities (Safety Guide)

GSG-3.5 The Management System for Nuclear Installations (Safety Guide)

GSG-4.1 Format and Content of the Safety Analysis report for Nuclear Power Plants (Safety Guide 2004)

SSR-2/1 Safety of Nuclear Power Plants: Design (Specific Safety Requirements)

SSR-2/2 Safety of Nuclear Power Plants: Operation and Commissioning (Specific Safety Requirements)

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

SSR-5 Disposal of Radioactive Waste (Specific Safety Requirements)

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)

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)

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

RS-G-1.1 Occupational Radiation Protection (Safety Guide)

RS-G-1.2 Assessment of Occupational Exposure Due to Intakes of Radionuclides (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)

WS-G-2.5: Predisposal Management of Low and Intermediate Level Radioactive Waste (Safety Guide)

WS-G-6.1 Storage of Radioactive Waste (Safety Guide)

Safety Report Series No.2 Optimization of Radiation Protection in the Control of Occupational Exposure

Safety Report Series No.11 Developing Safety Culture in Nuclear Activities Practical Suggestions to Assist Progress

Services Series No.12 OSART Guidelines

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

EPR-ENATOM-2002 Emergency Notification and Assistance Technical Operations Manual

EPR-METHOD-2003 Method for developing arrangements for response to a nuclear or radiological emergency, (Updating IAEA-TECDOC-953)

EPR-EXERCISE-2005 Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency, (Updating IAEA-TECDOC-953)

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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