IAEA Operational Safety Review Team OSART

REPORT

OF THE

OPERATIONAL SAFETY REVIEW TEAM

(OSART)

MISSION

TO THE

TIHANGE

NUCLEAR POWER PLANT

BELGIUM

17 APRIL TO 4 MAY 2023

DIVISION OF NUCLEAR INSTALLATION SAFETY
OPERATIONAL SAFETY REVIEW MISSION
IAEA-NSNI/OSART/218/2023

PREAMBLE

This report presents the results of the IAEA Operational Safety Review Team (OSART) review of Tihange Nuclear Power Plant Unit 3, Belgium. It includes recommendations and suggestions for improvements affecting operational safety for consideration by the responsible Belgian 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 Belgian organizations is solely their responsibility.

FOREWORD
By the Director General

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

An OSART mission, carried out only at the request of the relevant Member State, is directed towards a review of items essential to operational safety. The mission can be tailored to the particular needs of a plant. A full scope review would cover ten operational areas: leadership and management for safety; training and qualification; operations; maintenance; technical support; operating experience feedback; radiation protection; chemistry; emergency preparedness and response and accident management. Depending on individual needs, the OSART review can be directed to a few areas of special interest or cover the full range of review topics.

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

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

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

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

EXECUTIVE SUMMARY

This report describes the results of the OSART mission conducted for Tihange Nuclear Power Plant Unit 3, Belgium from 17 April to 4 May 2023.

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

This OSART mission reviewed ten areas: Leadership and Management for Safety; Training and Qualification; Operations; Maintenance; Technical Support; Operating Experience Feedback; Radiation Protection; Chemistry; Emergency Preparedness & Response and Accident Management.

The mission was coordinated by an IAEA Team Leader and Deputy Team Leader and the team was composed of experts from Bulgaria, Romania, Slovak Republic, Slovenia, Spain, Sweden, United Arab Emirates, United Kingdom, three IAEA staff members and one observer from United Arab Emirates. The collective nuclear power experience of the team was 358 years.

The team identified 14 issues, five of them are recommendations, and nine of them are suggestions. Four good practices were also identified.

Several areas of good practices were noted:

- The plant had developed an integrated tool to support fire hazard analyses which included assessments for the fire resistance of fire separation barriers, calculations for fire propagation in multi-compartment configurations and an algorithm for taking fire extinguishing systems into account in the calculation of fire growth and propagation.
- The plant integrated permanent design modifications into a structured project management system, ensuring that the plant's resources and requirements were all aligned and followed a graded approach based on safety and complexity.
- If a severe accident occurred which resulted in a core melt, the plant had designed and installed equipment for the stabilization of the reactor core to prevent further degradation of the core. Furthermore, the plant had strategies and procedures in place for the use of this equipment.

The most significant issues identified were:

- The plant should enhance the design, operating parameters and operational capability of the full scope simulator to sufficiently replicate the unit 3 main control room (MCR), ensuring operators can train the practical skills required for the safe operation of the plant.
- The plant should enhance its processes, procedures and practices for managing temporary modifications to limit their number and duration in order avoid an additional burden for maintenance and operations and to minimize their cumulative safety significance.
- The plant should improve the work management system in order to improve work preparation, scheduling adherence and minimize backlogs.

Tihange 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 Belgium, an IAEA Operational Safety Review Team (OSART) of international experts visited Tihange Nuclear Power Plant Unit 3 from 17 April to 4 May 2023. The purpose of the mission was to review operating practices in the areas of Leadership and Management for Safety; Training and Qualification; Operations; Maintenance; Technical Support; Operating Experience Feedback; Radiation Protection; Chemistry; Emergency Preparedness & Response and Accident Management.

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 Tihange Unit 3 Nuclear Power Plant is one of three units with a total site capacity of 2985 MWe located on the shore of the Meuse River, approximately 25km South-west of Liege city in central Belgium. The plant is owned by Engie Electrabel and operated by Engie Electrabel. Unit 3 is of Westinghouse 1038MWe PWR type and it went into commercial operation in September 1985. The Tihange site employed approximately 1000 staff across all three units.

The Tihange OSART mission was the 218th in the programme, which began in 1982. The team was composed of experts from Bulgaria, Romania, Slovak Republic, Slovenia, Spain, Sweden, United Arab Emirates, United Kingdom, three IAEA staff members and one observer from United Arab Emirates. The collective nuclear power experience of the team was 358 years.

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

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

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

MAIN CONCLUSIONS

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

- The plant had developed an integrated tool to support fire hazard analyses which included assessments for the fire resistance of fire separation barriers, calculations for fire propagation in multi-compartment configurations and an algorithm for taking fire extinguishing systems into account in the calculation of fire growth and propagation.
- The plant integrated permanent design modifications into a structured project management system, ensuring that the plant's resources and requirements were all aligned and followed a graded approach based on safety and complexity.
- If a severe accident occurred which resulted in a core melt, the plant had designed and installed equipment for the stabilization of the reactor core to prevent further degradation of the core.

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

- The plant should enhance the design, operating parameters and operational capability of the full scope simulator to sufficiently replicate the Unit 3 main control room (MCR), ensuring operators can train the practical skills required for the safe operation of the plant.
- The plant should enhance its processes, procedures and practices for managing temporary modifications to limit their number and duration in order avoid an additional burden for maintenance and operations and to minimize their cumulative safety significance.
- The plant should improve the work management system in order to improve work preparation, scheduling adherence, and minimize backlogs.

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

1. LEADERSHIP AND MANAGEMENT FOR SAFETY

1.1. LEADERSHIP FOR SAFETY

The plant management team had established a clear vision and strategy which, in conjunction with the management system, had contributed towards improving the performance of the plant. The plant used ‘Rosette’, a picture summarizing nuclear safety culture and defense-in-depth principles. The model underlined the significance of each individual worker’s contribution to the defense-in-depth principles and promoted a positive nuclear safety culture. The plant used the ‘Rosette’ model frequently (for example during training, briefings, meetings, operating experience analysis etc.) to communicate and reinforce worker contributions towards improving safety and culture. To reinforce work practices and behaviours in the field, plant management had taken initiatives to strengthen the accountabilities and ability to give constructive feedback for first and second line managers. The team recognized the use of the initiatives as good performance.

1.3. CULTURE FOR SAFETY

The team did not undertake a detailed safety culture assessment at the plant. However, the overall experience of the team was utilized to capture safety culture attributes, behaviours and practices which help to shape and define the safety culture at the plant. With respect to observed strengths, the team noted that the strongest characteristic was that ‘Leadership for safety is clear’ for the plant. The plant managers were clearly committed to safety, translating safety culture into practice and providing the plant personnel with their full support in adhering to policies and procedures. The plant managers spent time in the field observing and listening to individuals and intervening when necessary to remedy safety issues.

However, the team noted that some attributes could be strengthened to improve the following safety culture characteristic: Accountability for Safety is Clear, and Safety is Integrated in all Activities. While there was evidence that employees and contractors had an understanding of the safety expectations and the need to improve safety performance, the team observed some deviations from established plant safety expectations and fundamentals such as: inconsistent use of Pre-Job-Briefs (PJBs) in addressing non-radiation-related safety hazards, unidentified safety hazards in the plant’s industrial areas and, in some cases, individuals not respecting lifesaving rules. The team also noted that consideration of all types of safety was not optimal during the preparation and conduct of the plant activities that sometimes resulted in material condition, labelling and housekeeping defects not being reported. In addition, maintenance tasks were not always prepared efficiently or completed to schedule. Contamination and radiation risks were not always minimized, and operational chemicals were not always properly labelled and controlled.

1.4. MEASUREMENT, ASSESSMENT, AND CONTINUOUS IMPROVEMENT

As part of the regular Nuclear Safety Culture Assessment programme, Nuclear Safety Culture surveys are undertaken periodically. However, when the last survey was performed in 2021, the participation rate was only 54 % (contractors included). The plant is encouraged to increase the participation rate for nuclear safety surveys in order to improve the validity of the analysis.

1.6. NON-RADIATION-RELATED SAFETY PROGRAMME

The team made a review of events, near-misses, and field observations and found weaknesses in identifying non-radiation-related safety hazards and communicating these to workers. While leadership values and management in the field programmes were established and clear, it was noted that there was inconsistent compliance with the non-radiation-related safety programme. The team made a suggestion in this area.

1.6. NON-RADIATION-RELATED SAFETY PROGRAMME

1.6. (1) Issue: Plant programme for non-radiation-related safety does not always ensure that non-radiation related safety hazards are identified and safety rules and practices complied with by workers, to reduce the number of incidents and events.

During the review the team noted:

- Several safety hazards in the plant's industrial area which had not been identified by plant personnel, such as:
  - Approximately 50% (15) of the caged ladders within the Turbine Hall did not have a safety chain or a self-closing gate at the top of the ladder to prevent falls from height.
  - Adjacent to a staircase in the bunker building there was a trolley which was not chained or blocked to prevent unintended movement.
  - In the Electrical building there was no visible line on the floor to identify a safe distance between the worker and the electrical cabinet to avoid unexpected contact.
  - In the Auxiliary building, YL-323, on the second floor, there was no sign for the exit route.
  - In the Mechanical workshop, there was an open cable penetration through the floor close to the wall, approximately 10 cm in diameter.
  - In the Mechanical workshop there was an orange bag (30 l) containing abrasive material stored in an unmarked area beneath an eye shower kit.
- The team noted inconsistent use of Pre-Job-Briefs (PJB) when discussing non-radiation-related safety. Examples were:
  - During a PJB prior to maintenance work on the replacement of a pressure transmitter on the G-train emergency diesel generator (EDG), non-radiation-related safety matters were not addressed. However, when Operations performed their PJB for their activities associated with the task, they addressed non-radiation-related-safety. Both departments have the same requirements from the plant to address non-radiation-related- safety matters during PJBs.
  - During the PJB for a task associated with carrying out battery checks, the supervisor was not clear if the PJB could be skipped as the PJB had been performed for the same work order the day before, with the same workers. The plant expectation is that a PJB should be given before starting work activities, and this was then clarified by the Human performance (HP) specialist who was observing the PJB.
- There were several examples observed by the team when the plant personnel did not wear appropriate Personal Protective Equipment (PPE). In all cases however, it was corrected by the plant counterparts. The examples ranged from not using a safety helmet chinstrap in a Foreign Material Exclusion (FME) zone (spent fuel pool), to not using the required ear protection or safety glasses.
- The Industrial Safety Accident Rate was monitored via two plant key performance indicators, frequency of accidents (Tf) and severity of accidents (Tg). However, the plant had not met the non-radiation-related safety accident rate targets for contractors for the last three years. In addition, at the time of the OSART mission, there had been four accidents resulting in injury. The plant had a target of no more than 12 accidents for the year 2023.

- For 2022, from an analysis of approximately 1,000 observations, there were 17 accidents with incapacities and 61 accidents without incapacities. However, the plant did not use near miss or unsafe condition information from manager in the field programme or from condition reports when presenting non-radiation-related-safety information at monthly performance review meetings. For example, in the monthly presentations of the accident triangle, the numbers presented were only 12 (near-misses) and 24 (unsafe situations), but in reality, there were more near misses and unsafe conditions being reported than those presented.
- For 2022, the main causes of incidents were:
  - Slips, trips and falls: 40%
  - Projectiles striking the face or eyes: 13%
  - Pinched limbs (finger, hands, etc.): 11%
  - Abrupt movements (ergonomics): 10%
  - Contact with chemicals: 7%

  Furthermore, analysis from 2022 field observations showed that 83% of high potential unsafe behaviours observed, were associated with not respecting Life Saving Rules.
- In 2022 the plant had 12 actions to improve industrial safety performance. Eight of these were closed on time, however, the remaining four were extended following specific analysis.
- A letter was sent to all contractor companies at the end of 2022 requesting action plans to improve non-radiation-related safety performance. They were asked to reply by the end of March 2023. Only 10% of the contractors had responded by end of March and only 22% by the 24 April 2023.
- Despite the measures taken, accidents still occur. Listed below are some recent examples of accidents which had occurred to contractors at Tihange Unit 3:
  - On 12 January 2023, when a worker was handling a piece of a material, it tipped over and injured his hand in two places. There was a deep cut in the left little finger and loss of sensitivity, resulting in 10 days of lost work.
  - On 3 January 2023, when removing a piece of material from the crane rolling device in the decontamination workshop, a worker was injured as a spring released unexpectedly, resulting in a facial injury and five days of time off work.
  - On 11 October 2022, a worker stepped on an unstable platform, twisting and breaking his ankle, resulting in 50 days of time off work.

Without identifying safety hazards and communicating mitigation measures to workers, non-radiation-safety events may continue to occur.

Suggestion: The plant should consider improving its ability to identify non-radiation-related-safety hazards and reinforce the compliance with non-radiation-safety rules and practices to prevent incidents and events.

IAEA Bases:

SSR-2/2 (Rev. 1) - Requirement 23: Non-radiation-related safety

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.

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3.2. The operating organization has the following main responsibilities:

(b) Establishing a safety policy, implementing operational policies, and developing and applying safety performance standards …

3.5. As noted in para. 3.2(b), the operating organization is required to establish safety performance standards and should effectively communicate these standards throughout the organization.

GS-G-3.1

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

2. TRAINING AND QUALIFICATIONS

2.2. QUALIFICATION AND TRAINING OF PERSONNEL

The Tihange Unit 3 Main Control Room (MCR) simulator was a modified version of the Tihange Unit 2 simulator, resulting in a significant number of hardware, software and plant operating parameter differences with Unit 3. Consequently, the Tihange Unit 3 simulator was not representative of the Tihange Unit 3 MCR plant design. As a result, control room staff had to be briefed on numerous configuration differences and in some cases were unable to be trained for specific scenarios in the simulator. The team made a recommendation in this area.

The plant used the Systematic Approach to Training (SAT) to ensure staff competency. However, in some cases, the application of the process was not comprehensive, particularly in the areas of individual trainee evaluation and the quality assurance of training documentation. The team made a suggestion in this area.

Specific simulator scenarios were developed with the aim of improving operators’ ability to apply operator fundamentals and human performance (HP) tools in the simulator. The sessions were also designed to improve the participant’s leadership and teamworking attributes. Participation in the debrief sessions by the operations engineer and shift supervisor helped to ensure that learning was taken back to the operations department and used to direct future continuing training sessions. The team noted this as a good performance.

A knowledge transfer process had been introduced at Tihange Unit 3 where the training department were informed of all leavers, retirees and departmental moves. Meetings were held to decide a course of action for all individual leavers such as conduct a face-to-face interview, create a knowledge mind map, conduct a yellow sticky exercise or take no action. This approach facilitated a systematic review and capture of knowledge and was recognized by the team as a good performance.

DETAILED TRAINING AND QUALIFICATION FINDINGS

2.2. QUALIFICATION AND TRAINING OF PERSONNEL

2.2 (1) Issue: The design, operating parameters and operation of the full scope simulator do not sufficiently replicate the Unit 3 Main Control Room (MCR) to ensure operators can train all the necessary practical skills for safe operation of the plant.

During the review the team noted:

- The Unit 3 simulator was based on the Unit 2 simulator which had been modified with additional panels and updated software. However, within the Unit 3 simulator there were a number of technical differences in hardware, control manipulation, protection systems operation, physical measurement systems and fundamental reactor operating parameters when compared to the MCR of Tihange Unit 3. The most significant differences were as follows:
  - The joystick to raise control rods in the Unit 3 simulator was manipulated in the opposite direction to the one in the Unit 3 MCR.
  - The chemical volumetric control system discharge valve open and closing switches were in opposite positions.
  - The average core temperature in the Unit 3 simulator was displayed as 303°C but was 312°C in the MCR.
- The equipment and operations differences relating to a particular training scenario had to be explained prior to the start of a Unit 3 simulator session, for which there was an approved 200-page document outlining the differences. Some of the layout and labelling was different and during simulator sessions, trainees at times, were observed calling to the instructor to confirm expected values and conditions that were not accurately represented by the simulator or reflected in Unit 3 procedures.
- On Unit 2 the three parallel isolation discharge valves on the volume control system (CCV, V402, 3 & 4) open slowly in a controlled manner over 100 seconds, but at Unit 3 the valves open quickly in approximately 10s. Consequently, the pressure of the volume control circuit must be controlled manually to avoid an uncontrolled pressure increase. An event of this nature occurred at Unit 3 in 2022, however the plant was not clear if simulator fidelity was a contributing factor in this event.
- There were differences in the isolation valves, boric acid pumps, reactor vessel ventilation and steam generator injection controls between the Unit 3 simulator back up control panel and the Unit 3 MCR back up panel.
- Certain training scenarios were unable to be trained on the Unit 3 simulator, which instead, must be facilitated by trainer manipulation of the simulator, to demonstrate the effects. Examples include:
  - Loss of plant compressed air system.
  - Some turbine events due to the lack of the full range of turbine indications.
- During Unit 3 simulator refresher training one of the trainees became confused with the procedure because they were not familiar with the manual manipulation of a switch on the simulator. This switch was applicable to Tihange Unit 2 but not to Tihange Unit 3.
- Trainees during the Unit 3 simulator feedback session repeatedly expressed strong opinions regarding their frustration and disappointment at having to train in a simulator with so many fidelity issues. They stated that this situation was difficult for them.
- Since the transition of Tihange Unit 2 NPP into decommissioning, some modifications were required to be made to the Unit 3 simulator, such as changes in labelling and

replacement of panels. However, due to a busy training schedule, these changes can only made by the contractor on an annual basis during the summer.

Training on a simulator which is not fully representative of the main control room may place operators at risk of making errors which could threaten the safe operation of the plant.

Recommendation: The plant should enhance the design, operating parameters and operational capability of the Unit 3 full scope simulator to sufficiently replicate the Unit 3 main control room, ensuring operators can train the practical skills required for the safe operation of the plant.

IAEA Bases:

SSR-2/2 (Rev.1) – Requirement 7: Qualification and training of personnel

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

4.20. 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.

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

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2.17 When selecting candidates to work as control room operators or as other personnel who might have to respond to an emergency, their ability to work together as a team in such conditions should be considered. In the allocation of staff to particular teams, the likely personal interactions should be taken into account.

4.2. The operating organization should formulate an overall training policy. This policy should describe the commitment of the operating organization and managers to the training of personnel and acknowledge the essential role of training in the safe and reliable operation and maintenance of the plant.

2.2 (2) Issue: The plant process for the implementation of a systematic approach to training is not sufficiently comprehensive in terms of individual trainee evaluation and training material quality assurance.

During the review the team noted:

- Licenced operators were reauthorised every two years in a structured and systematic way, culminating in a panel decision. However, for the theoretical training elements of the reauthorisation, students were permitted to self-study and sign their own confirmation of understanding without having any formal assessment of the reauthorisation theoretical training.
- Simulator continuing training evaluations were conducted as team focused reviews and there were no individual examinations or assessments for the simulator continuing training. Furthermore, for other training programme areas such as: Engineering, Maintenance, Emergency Arrangements etc, there was no requirement for individual formal continuing training evaluations. For example, for personnel involved in emergency exercise demonstrations there was no formal individual continuing training evaluation.
- During confined space supervisor training, one of the three trainees did not perform the physical demonstration of entry into the mock-up confined space facility. The instructor explained that the individual was experienced and frequently performed this task, so it was not necessary to observe him carrying out the practical demonstration.
- Nuclear safety culture initial training for contractors was evaluated by a theory test and also by a practical assessment. However, completion of the practical assessment documentation took place at the end of the day, after the practical was finished, contrary to plant expectations that the assessment must take place during the practical. The instructor had to retrospectively assess five trainees against a large number of evaluation criteria.
- Initial training programmes were evaluated at three levels (trainee reaction, trainee understanding and knowledge application in the workplace) but not at level four (improvement to the business or plant performance).
- The electrical foreign material exclusion (FME) training session was based on theoretical training and only the mechanical team training included a practical demonstration to confirm competence. However, there was operating experience in the training material relating to an incident where Foreign Material was left in an electrical cabinet.
- Training materials for theory-based refresher training were not formally reviewed and issued as controlled documents. Lesson plans were created retrospectively after the training session. Lesson plans for training sessions shorter than a day, were not required, even when the session was delivered numerous times by different instructors. For the confined space supervisor refresher training, several variances were noted between the lesson plan and training material. For example, the lesson plan for Human Performance (HP) theory training did not contain a SAP (system for managing training course records) code, a title for the training, a reference or link to the approved training materials and was not signed or dated as approved for use.
- Simulator instructors had a training programme to become qualified which included conducting the same training as a licenced operator and courses on instructional techniques, adult learning theory and classroom delivery, however, they were not trained in the Systematic Approach to Training.

Without a comprehensive process for the development and evaluation of trainees using a systematic approach, the competences necessary for performing a job may not be achieved.

Suggestion: The plant should consider enhancing the implementation of the systematic approach to training processes for trainee evaluation and training material quality assurance to ensure trainees have the required competencies for safe plant operations.

IAEA Bases:

SSR-2/2 (Rev. 1) – Requirement 7: Qualification and training of personnel

4.19. A suitable training programme shall be established and maintained for the training of personnel before their assignment to safety related duties. The training programme shall include provision for periodic confirmation of the competence of personnel and for refresher training on a regular basis. The refresher training shall also include retraining provision for personnel who have had extended absences from their authorized duties. The training shall emphasize the importance of safety in all aspects of plant operation and shall promote safety culture.

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.

SSG-75

2.17 When selecting candidates to work as control room operators or as other personnel who might have to respond to an emergency, their ability to work together as a team in such conditions should be considered. In the allocation of staff to particular teams, the likely personal interactions should be taken into account.

3.1…The criteria for competence and qualification should be established in such a way as to ensure that the competences are appropriate to the tasks and activities to be performed.

3.5. The competence of each individual should be assessed against established criteria before that individual is assigned to a position. The competence of all individuals should be reassessed periodically while they perform their duties in the workplace.

4.9. The operating organization should ensure the following with regard to personnel performing safety related activities:

……

(d) The performance of trainees is assessed at various stages of the training.

(e) The effectiveness of the training is evaluated, in accordance with para. 4.23 of GSR Part 2 [3].

(f) The competence of personnel is periodically checked, and continuing training or retraining is provided on a regular basis, in accordance with para. 4.19 of SSR-2/2 (Rev. 1) [1]

3. OPERATIONS

3.1. ORGANIZATION AND FUNCTIONS

The plant had implemented periodic Unit 3 operations oversight reviews. The department head and his deputy took part in these sessions, together with a representative from a sister plant. The purpose was to check the efficiency of plant processes and compliance with fundamental expectations. The team recognized this as a good performance.

The plant had implemented a process to evaluate each shift crew and develop areas for improvement tailored to the team. All this information was centralized by the Operations Head of Department, enabling them to develop an overview of how each shift crew functions. This also included an assessment of the technical and team working competencies (specifically in areas such as leadership, human performance tools and relations within the crew). The team recognized this as a good performance.

3.3. OPERATING RULES AND PROCEDURES

A review of plant policy and procedures revealed that, although there was a procedure for the development and use of operator aids, several unauthorized operator aids and other unauthorized information and materials were found around the plant. The team made a suggestion in this area.

3.4. CONDUCT OF OPERATIONS

Operations personnel did not always identify and report field deficiencies in a timely manner to ensure that they could be effectively addressed. The plant had well defined procedures for the routine inspections of premises, but these were not always implemented in the field. There were examples of unidentified and unreported material conditions, labelling, foreign material, and housekeeping deficiencies. The team made a recommendation in this area.

3.5. WORK CONTROL

In the tagging procedures, there was a requirement for an independent verification of the equipment requiring isolation, but not for an independent verification of equipment position after tagout, except for electrical equipment and some chemical equipment. The safety systems line-up procedures only required independent verification for the main components. None of the surveillance tests procedures had a section for an independent verification of equipment position after a test. In recent operations history, some minor events happened due to incorrect equipment position following plant re-instatement. The team encouraged the plant to review the scope of independent equipment verifications during equipment re-instatement.

3.6. FIRE PREVENTION AND PROTECTION PROGRAMME

The plant had developed an integrated tool to support fire hazard analyses (FHA). The FHA methodology was developed based on the IAEA's Fire Containment Approach (FCA) and Fire Influence Approach (FIA) and was used to demonstrate that the fire safety goals were met in case of a single internal fire. This integrated tool included assessments for the fire resistance of fire separation barriers, calculations for fire propagation in multi-compartment configurations and an algorithm for taking fire extinguishing systems into account in the calculation of fire growth and propagation. The team recognized this as a good practice.

3.3. OPERATING RULES AND PROCEDURES

3.3(1) Issue: The plant arrangements for the management of unauthorized operator aids are not optimal to ensure the correct identification and management of equipment, and proper operator and maintainer manipulations.

During the review the team noted:

Unauthorized Operator Aids

- Unauthorized markings were observed on the thermal insulation of the reactor boron and water make up system, P183REA01 and label REA-05B had been corrected by hand to REA-05A.
- Unauthorized handwriting was found on the nuclear sampling system panel CEN-Q126.
- During the plant tour, handwritten information was observed on valves operated by chemistry personnel in multiple rooms in the Spent Fuel Pool Building, for example on component cooling system CRI-Train 1.
- In an electrical room, label MTN-TR4-N1 on a 6.6kV electrical panel was corrected manually.
- During a walkdown with a field operator in the bunker building, unauthorized operational information was observed on electrical cabinet TL01/I in room I401.
- There was unauthorized marking on plant turbine lubrication jacking and turning system control panels Co404/RST HGS. There were two switch positions which had handwritten ‘Start & Stop’ markings, and on control panel Co452/HGS the switch position had unauthorized handwritten information ‘Turn off Bottom to Top 8,7,6,4,5.
- Unauthorized handwriting was found on the control panel in Turbine Hall. (Six switches with handwritten markings – ‘I61, Q22, F35, I60, Q23, F34’, and handwritten ‘Events’ on the panel).
- An informal operator aid was observed in the Containment Filtered Vent System (CFVS) valve rooms. (‘396>x>199, Thursday 13h 15’)
- In room S350 on S311 door, handwritten information was found containing directions to three underground galleries and the same information was found to room S311 train B diesel generator electrical room.

Unauthorized information for maintenance activities:

- In room S330 for diesel train G:
  - Handwritten information indicating the position for the shaft alignment between the generator and the diesel.
  - Handwritten indication on the wall for the location of two valves.
  - Informal handwritten information on warehouse material reservation tag on service water system, CEB-V664.
  - Hand drawn hook to indicate location of lifting positions in two locations.
- In room S320 for diesel train R:
  - Unauthorized marking (handwriting) for the plate alignment on the generator in two locations.

- Unauthorized marking (handwriting) for the re-assembly positions for the nuts on the generator in two locations.
- Unauthorized marking (handwriting) for indication of the (XYZ) phase rotation on the generator.

In the Turbine Hall

- Handwritten information on the thermal insulation – 'Top left rod hatch' on ETAGE +3 level.

Without effective controls on equipment information within the work areas, unauthorized operator information may cause improper operator or maintainer actions, and thus cause equipment failure or unexpected equipment operations.

Suggestion: The plant should consider enhancing its arrangements for the management of unauthorized operator aids to ensure the correct identification and maintenance of equipment.

IAEA Bases:

SSR-2/2 (Rev.1) – Requirement 26: Operating procedures

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

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

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

3.4. CONDUCT OF OPERATIONS

3.4(1) Issue: Field operator walkdowns do not always identify and report material condition, labelling, foreign material exclusion (FME) and housekeeping deficiencies.

During the review the team noted:

Material Condition:

- During a walkdown with a field operator in the Radiological Controlled Area (RCA), corrosion on nuts and flanges on the high head safety injection pump, low head safety injection pump and containment spray pump were not reported.
- There were deposits of boron at the safety injection pump's seal drain collector. The field operator did not notice and when questioned about the condition by a member of the OSART team, the field operator then reported the deficiency.
- During a walkdown with a field operator in the RCA, a damaged flexible conduit, carrying a cable coming from cabinet SAN133-AN132, was found near the nuclear island deaerated demineralized water system valve EDDV402 which was not noticed by the field operator.
- There was an unreported oil leak (approximately 10 cm^2) under the outer side of the electric motor of chemical volume control system pump, CCV-P06B, with no defect tag present.
- In the first level diesel generator building there were four small puddles (1cm x 4cm) of oil located under emergency diesel generator No. 3 with no leak defect tag.
- During a walkdown in the turbine hall, a team member noticed that the thermal insulation on a section of the pipe was not closed off by the aluminum sheeting. Furthermore, the thermal insulation was breaking up and had spread to the surrounding area.
- During a walkdown with a secondary side field operator, the field operator did not notice the partially dismantled thermal insulation of a pipe between the circulating water system valves CECF48 and CECF27.

Labelling:

- A detached label for a pressure gauge on the safety diesel group, GDS LP309 was identified by the operator performing the diesel test. However, at the end of his shift, he did not record this defect into the SAP plant defect management system or make a request to the person responsible for replacing defective labels.
- In the diesel generator room, train G there were many labelling issues such as: missing pressure transmitter label, detached pressure instrument label, and three labels were found on the floor.
- In the area of the spent fuel cooling pumps there was a detached label marked CT9717 D307.
- During a walkdown with a secondary side field operator, he did not notice an illegible label on the suction side of the circulating water system pump CECP03.
- During a walkdown with a secondary side field operator, he did not notice a missing label on the auxiliary steam supply system valve, CVAV1295 near pillar/column E2. There was only a handwritten label.
- During a walkdown with a field operator in the RCA, there were handwritten information on the wall (CAEV767 and CAEV768) designating the position of the auxiliary steam supply system valves. The field operator did not raise a request for official labels.

Foreign Material Exclusion (FME)

- During a walkdown with a field operator in the RCA, a plastic cap and screw were found in a sample collector near the nuclear island deaerated demineralized water system valve EDDV402, leading to a risk of foreign material intrusion. The field operator did not notice. The counterpart removed the cap and screw.
- During a walkdown with a field operator in the RCA, a locking chain was left in a sample collector near the nuclear island deaerated demineralized water system valve EDDV407, leading to a risk of foreign material intrusion. The field operator did not notice. The counterpart removed the chain and hung it on the chain hanger.
- During a walkdown in the turbine hall with a secondary side field operator, it was observed between pillars/columns E7 and E8 that two condensate extraction pumps each had a pipe to connect to the mechanical seal for the purpose of manual leak removal, if required. However, the 30 mm pipes did not have any FME covers on their open ends. The field operator did not notice this.

Housekeeping:

- During a walkdown with a secondary side field operator, a large rubber fire hose (approximately 30 cm diameter and approximately 30 m length) was observed near pillar/column A4 in the Turbine Hall. The hose was lying on the floor in a disorderly manner and was folded at several points. The hose was connected to fire protection pipelines, with its other end laid out towards the lower elevations of the turbine hall. The purpose was to provide cooling water to components in the turbine hall in case of station blackout (permanent modification). The field operator did not notice that there were no warning signs for the tripping hazard.
- During the plant tour, the presence of waste (old metal labels and a piece of metal wire) was observed on the floor near a 6.6 kV cable supplying safety injection pump CISP04B in room N014.
- During a walkdown with a field operator in the RCA, in the lower elevation of the spent fuel pool building, the field operator noticed a harness and rope left near the spent fuel pool but did not take any action.
- In the turbine hall, the lifting equipment storage area was untidy, with loose bolts, metal wire and various other items piled into boxes.
- During a walkdown in the turbine hall, a team member noticed:
  - A 20cm spanner had been left lying on the floor under a cooling unit in the turbine building
  - There were three loose metal parts on top of insulated valve box REA/SP233.

Management expectations

- During a walkdown in the Turbine Hall, a field operator did not use a general checklist to remind them of the types of deficiencies to look out for. They only had a portable device with a list of equipment parameters to check and record during the walkdown.
- The procedure for performing walkdowns by field operators had very clear requirements on the technical aspects of walkdowns (to check parameters, to check for abnormal noises, to check the temperature of motors, etc.), but expectations for recording and reporting deficiencies related to FME, industrial safety hazards, etc. were not described.

Insufficient attention from plant personnel to deficiencies related to material condition, labelling, FME and housekeeping could lead to safety equipment degradation or increased risk of personal injuries.

Recommendation: The plant should improve its expectations for the identification and reporting of material condition, labelling, foreign material and housekeeping deficiencies during field operator walkdowns.

IAEA Bases:

SSR-2/2 (Rev.1) - Requirement 28: Material conditions and housekeeping

7.10. ……Equipment that is degraded (owing to leaks, corrosion spots, loose parts or damaged thermal insulation, for example) shall be identified and reported and deficiencies shall be corrected in a timely manner.

7.11. An exclusion programme for foreign objects shall be implemented and monitored……

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

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4.41. Any problems with equipment that is observed during shift rounds should be promptly reported to the control room personnel and corrective action should be initiated. Factors that should typically be noted and reported include the following:

(a) Deterioration of material conditions of any kind, including corrosion, leakage from components, accumulation of boric acid, excessive vibration, unfamiliar noise, inadequate labelling, foreign bodies and deficiencies necessitating maintenance or other action;

(b) Any issues associated with the operability and calibration status of measurement and recording devices and alarms on local panels throughout the plant, and their readiness for actuating or recording;

(c) Any issues associated with the authorization for, and the condition and labelling of, temporary modifications in the field (e.g. the presence of blind flanges, temporary hoses, electrical jumper wires and lifted leads in the back panels);

(d) Indications of deviations from good housekeeping, for example the condition of components, sumps, thermal insulation and painting; obstructions; unusual smells, posting of signs and directions in rooms; posting of routes and lighting; and posting and status of doors;

(e) Deviations from the rules for working in safety related areas such as those relating to welding, the wearing of personal protective equipment, radiation work permits or other safety matters;

(f) Any issues associated with the arrangements for fire protection (e.g. deterioration in fire protection systems or in the status of fire doors and dampers; deterioration of fire rated barrier penetration seals; accumulations of materials posing fire hazards such as wood, paper, refuse and oil), or with non-radiation-related safety problems (e.g. leakages of fire resistant hydraulic fluid13, hazardous equipment, trip hazards);

(g) Deviations in other safety protection devices, such as flooding protection, seismic constraints and unsecured components that might be inadvertently moved;

(h) Deviations from the foreign material exclusion programme.

5.19. ... Observation and reporting of foreign materials should be part of the plant walkdowns conducted by field operators and managers.

6.23. …The operations department should periodically monitor housekeeping and material conditions in all areas of the plant and should initiate corrective action when problems are identified.

6.27. Plant areas and plant systems and their associated components should be clearly and accurately marked, allowing operating personnel to easily identify the equipment and its status. This includes, for example, the marking of isolations, the positions of valves, trains of protection systems and the electrical supply to different systems.

3.6. FIRE PREVENTION AND PROTECTION PROGRAMME

3.6(a) Good Practice: The plant had developed an integrated tool to support fire hazard analyses which includes assessments for the fire resistance of fire separation barriers, calculations for fire propagation in multi-compartment configurations and an algorithm for taking extinguishing systems into account in the calculation of fire growth and propagation.

Purpose:
Development of an integrated tool for automatic fire containment analysis during Fire Hazard Analysis (FHA) which includes:

- Automatic calculation of fire growth and propagation
- Assessment of the fire resistance of separation barriers
- Calculation of fire propagation in a multi-compartment configuration
- 'System Assessment' to address the significance of safety equipment lost due to a postulated fire.

A secondary advantage is the use of a single database capturing all data related to fire protection features.

Description:
Following the introduction of the WENRA Reference Levels in Belgian regulations at the end of 2011, a comprehensive Fire Hazard Analysis (FHA) study became mandatory for all Belgian nuclear power plants (NPPs). Seven units, representing more than 7,500 rooms, had to be assessed.

The FHA methodology was developed based on the IAEA's Fire Containment and Fire Influence Approaches (FCA and FIA) and is used to demonstrate that in the event of a single internal fire, the fire containment measures were sufficient to enable the reactor to be safely shutdown, residual heat from the fire to be removed and that the containment of radioactive material would be maintained.

Given the high number of rooms to be analyzed, a specific tool was developed for automatic FCA analysis (a first of its kind in the world).

The resulting FCA analysis was a deterministic screening method that assessed fire compartmentalization, taking into account the actual fire loads inside the rooms. The method consisted of:

- Numerically characterizing the separation walls in terms of fire rating capability (thermal insulation, integrity, load bearing) by calculating the thermal characteristics of separation walls and using the known fire rating of walls and the ISO 834 curve.
- Determining the fire curves inside a room by considering different ventilation modes.
- Assessing fire propagation through separation walls (and through existing openings).
- Creating a recursive loop to reapply steps 2 and 3 in case of fire propagation(s) to neighbouring rooms.

The calculation is a recursive process which considers three ventilation conditions inside the burning space (Figure 1):

- No ventilation ("closed"): the fire is only fed by the air present in the room;
- Natural ventilation: the fire is fed by the air coming from neighbouring rooms in the compartment, through permanent openings;
- Forced ventilation: the fire is fed by mechanical ventilation.

Note: the possibility of reaching flashover conditions and of interactions between automatic fire protection systems was also taken into account in the fire growth calculation.

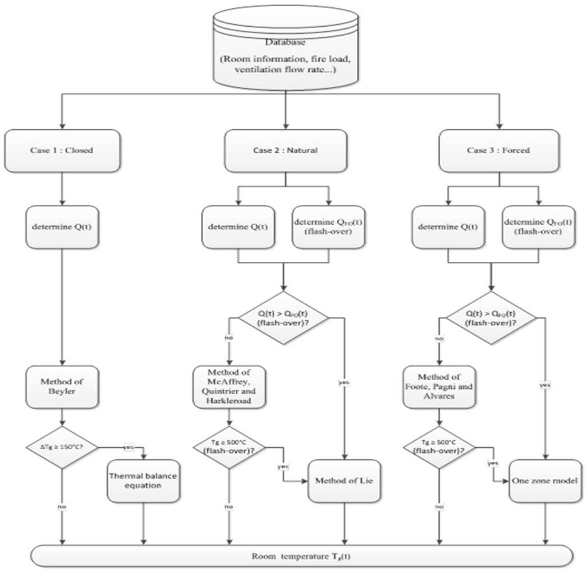


Figure 1: Flowchart Showing Fire Containment Calculation Process

After all fire propagations have been calculated, a "System Assessment" is performed to address the significance of lost safety equipment located in the rooms potentially impacted by the fire scenario. This 'System Assessment' assesses the plant's ability to reach a safe shutdown state. The analysis takes the combinations of independent events into account: a Large Break Loss Of Coolant Accident (LBLOCA), Loss Of Offsite Power (LOOP), and a Safe Shutdown Earthquake (SSE).

All the data is geo-localized and structured by categories (type of fire load, safety equipment, detection means, etc.) per room, in a graphical user interface and on plant drawings (figure 2):

- general room information (geometry, layout, etc.)
- fire load characteristics
- fire load locations
- wall/floor/ceiling characteristics such as fire ratings, openings, etc.
- locations and types of fire detectors
- locations and types of manual and automatic fire suppression systems
- presence and identification of FHA safety equipment, cables and ventilation flow rates

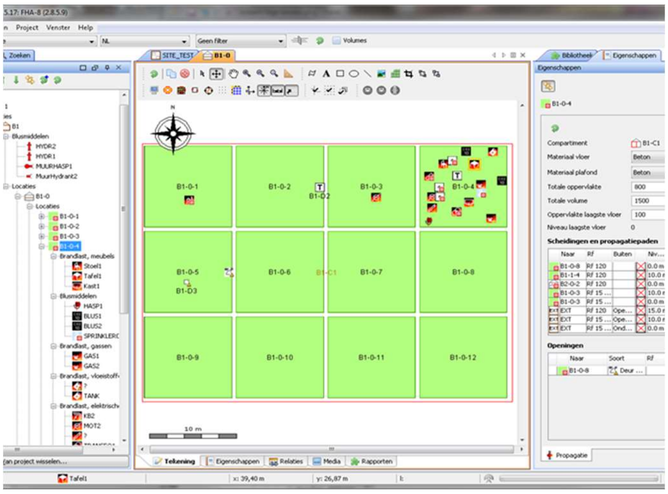


Figure 2: Graphical user interface

In order to perform the study and update it in the future, a software tool was developed internally to allow:

- data acquisition
- fire growth and propagation calculations
- system assessment reporting.

The tool also provided an assessment of fire detection adequacy, and of manual (hydrants, portable extinguishers) and automatic extinguishing systems (figure 3).

The tool automatically assesses a number of criteria based on prescriptive requirements and generates visual aids to perform the study (red circle showing the covered zone).

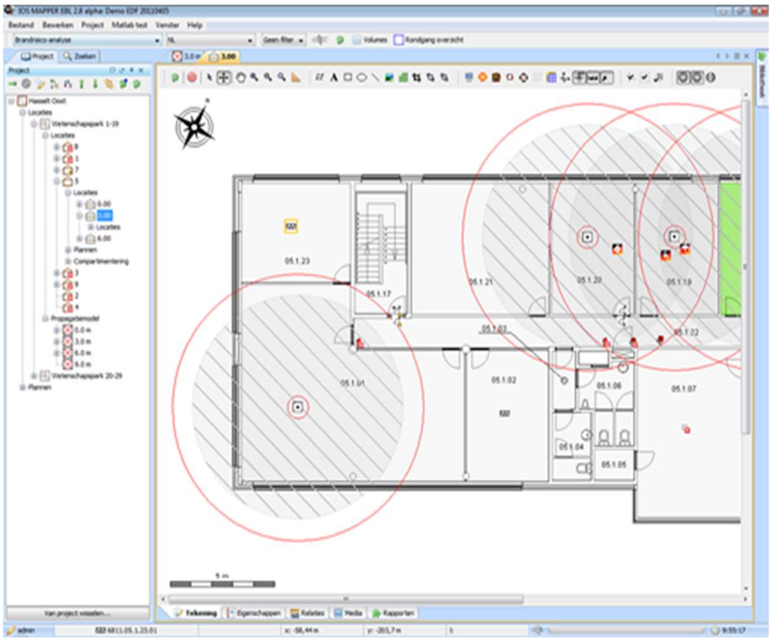


Figure 3: Assessment of fire detection adequacy

Benefits:

- Time saving: the FCA methodology that has been developed is a new and simplified method for automatically assessing and screening compartmentalization in nuclear power plants, as part of a Fire Hazards Analysis.
- The methodology meets international standards since it was developed in line with IAEA approach to conducting FHA.
- Quality assurance: the data used for the analysis are all subject to the same quality assurance process and are all available in a single database. The use of the tool significantly improves the consistency of the studies across all units.
- Exchange of information: the tool provides proper traceability of data and results and facilitates the exchange of data with regulatory bodies.
- The tool and method that were developed provide a quick overview of the adequacy of the fire protection systems installed in NPPs.
- The tool will facilitate future updates of FHA studies.

4. MAINTENANCE

4.2. MAINTENANCE FACILITIES AND EQUIPMENT

The Training Centre was used for theoretical and practical training for all personnel, including maintenance personnel. In order to increase the understanding of the requirements for working inside the plant, a number of worksite mock-ups have been put together, representing different working environments. The team considers this to be a good performance.

4.5. CONDUCT OF MAINTENANCE WORK

The Maintenance department had reinforced its expectations regarding procedure adherence, risk awareness, quality of preparation, work completion and the usage of error prevention tools to minimize the amount of rework and avoid non-radiation-related safety and nuclear safety related events. Personnel ownership was high due to a strong, transparent bottom-up management culture. The manager in the field programme (MIF) was also being used to reinforce expectations and the target for managers being in the field had recently been increased. However, the team noted that maintenance personnel do not always follow plant standards. The team encourages the plant to continue its efforts to improve the MIF process to ensure full compliance with plant standards and expectations.

4.6. MATERIAL CONDITION

The plant had developed a system called 'WESTI' to track mobile equipment, monitor low level radioactive waste accumulation and manage fire loads within storage areas. The team considered the use of this system as a good practice.

4.7. WORK CONTROL

The work management system did not always ensure that maintenance work was prepared and completed to schedule and that maintenance backlogs were minimized. The team made a recommendation in this area.

The work planning process permitted equipment from one safety train at a time to be taken out of service for maintenance purposes. However, since there were no access controls in place, operations personnel were not always aware if there were personnel present in the rooms containing equipment from other safety trains. The team encourages the plant to strengthen the processes for limiting the access to rooms containing safety train equipment.

4.6. MATERIAL CONDITION

4.6(a) Good practice: The plant had developed a system called 'WESTI' to track mobile equipment and low-level radioactive waste and to aid the management of storage areas and associated fire loads.

Purpose

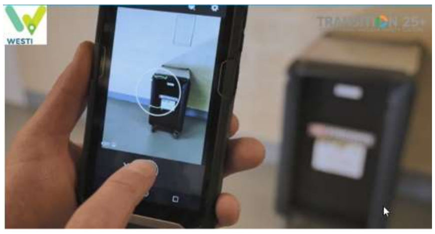
The purpose of the system was to track the storage of low-level radioactive waste and mobile equipment and to manage the build-up of combustible material in storage areas.

Description

The system was composed of a mobile scanner supported by a user-friendly application, barcode stickers, and a docking station to synchronize the device and desktop interface to set up the application. One of the goals of the application was to easily locate mobile equipment. Different properties can be assigned to the mobile equipment to provide more relevant information, such as the owner, type of equipment, maintenance requirements etc. The device can also record important information for the storage of low-level radioactive waste and the storage of combustible material at designated storage locations.

An important feature was the provision of up to three pictures for every item of equipment, which aided the assessment of any hazards. This feature was particularly valuable in the case of containers or closed boxes. The use of this device had improved safety, enhanced fire protection and radiation protection measures.

Supporting details and examples:



Benefits:

- Easy to use mobile interface with a high-quality barcode scanner.
- The system can be developed to meet the needs of the plant.
- Mobile devices are available for all teams and also in the tool stores (about 150 devices on site).
- The desktop interface offers flexibility so that the application can be adapted to each user's needs due to the versatility of the software.
- Photographs can be taken with the device and then linked to the profile created in the system.
- For fire protection, the fire load at any particular storage location can be estimated and then compared with the admissible load.
- For radiation protection, the dose is estimated and assigned to each waste bag. If a waste bag is incorrectly classified, the owner of the waste bag is given coaching.
- For safety, the accurate location of mobile equipment supports effective configuration management.
- In addition, the use of these devices has resulted in an overall improvement in plant housekeeping.

4.7. WORK CONTROL

4.7 (1) Issue: The work management system does not always ensure that maintenance work is prepared and completed to schedule, and maintenance backlogs are minimized.

During the review, the team noted:

Deviations in Work Preparation:

- The required tools, materials and manpower were stated in the work planning process. However, during preventive maintenance on the gaseous waste treatment system actuator TEG-V529-S in the Radiological Controlled Area (RCA), the procedure was not updated to specify the correct wrench size and the lighting in the room was defective, causing a delay in the work execution.
- During a Pre-job Brief (PJB) prior to maintenance work to replace a pressure transmitter on G-train EDG, an error in the procedure was recognised during the preparation prior to the work and through the plant's just-in-time qualification process, a handwritten amendment was made to the procedure and signed-off by an authorized person. However, it was not clear what steps were to be taken to ensure the procedure was updated prior to its next use.
- During PJB prior to maintenance work to replace a pressure transmitter in safety train G for the Emergency Diesel Generator (EDG), the procedure was followed. However, a significant number of risks were identified during the actual maintenance work but were not mentioned during the PJB. Examples of risks identified included; the importance of a moderate pressure increase when calibrating the new pressure transmitter to avoid damaging the instrument, making sure that the connections were in the same position as for the former transmitter, and the identification of other equipment near the workplace which could be adversely impacted during the execution of the maintenance task. In addition, during the task significantly more oil came out of the transmitter than expected.
- Risks identified during the PJB prior to maintenance work were not always captured in a systematic way as operational experience and were therefore not available for upcoming work on the same Structures, Systems and Components (SSCs).
- The plant applied the NCR (non-compliance with the regulation) process to justify if non-qualified spares could be used in situations where there was a delay in obtaining the qualification for the spare part. At the time of the review, there were 26 ongoing NCRs including one dating back to July 2022 with 18 related to spare parts. The plant target was to have zero deviations involving the use of NCRs. The use of NCRs was followed by the management team through the Site Operations Review Committee (SORC) with dedicated resources to minimize the duration of the NCR. However, when the NCR process was used to justify the use of a new type of connector, no additional actions were set to improve the timeliness for the formal equipment qualification for these new types of connectors.
- In total, the plant had approximately 125,000 spare parts. 25,000 of which were subject to quality assurance. Approximately, 500 items had triggered an alarm for low critical stock levels. Approximately 450 had been ordered but not yet received. 56 critical components related to safety were classified storage level zero, of which, 44 had been taken out for maintenance work but would be returned since they were not needed. For the twelve components related to safety which were classified storage level zero, the required quality assurance documentation was outstanding.

Work Scheduling:

- During the last outage in 2022, there were 4,492 work orders at the scope freeze date. However, after that date an additional 849 work orders were added to the schedule, 102 of which (12%) were associated with preventative maintenance tasks. The need to incorporate these preventative maintenance tasks was known before the scope freeze date, yet they were only included in the outage schedule after the scope freeze date had passed.
- The plant had introduced a new work management scope control Key Performance Indicator (KPI) together with a new process for the monitoring of additional work orders. However, the work management scope control KPI for the four-week planning process at the time of the OSART mission was between 70-75%.
- A planned urgent (CT3-D-U) corrective maintenance activity on a bearing for a ventilation system (VBI) in the Electrical building was postponed for eight weeks at the request of Maintenance. This was due to a lack of maintenance resources.
- If an extension to the duration of a work order was needed, plant procedures required a justification and approval. However, only extensions related to safety significant re-planning were required to go into the operating experience (OE) system. In addition, extensions that were logged in the OE database were hard to retrieve, since they are not tagged with any extension code.

Maintenance Backlogs:

- The backlog for corrective maintenance had reduced by 67 % from 2020 to 2022. However, at the time of the review, the backlog in corrective maintenance was 408 items, 127 of which were for safety related equipment. The backlog for preventative maintenance was 130, 18 of which were for safety related equipment.
- There was no specific KPI for monitoring longstanding backlogs. The evaluation of backlogs was only trended in absolute figures, on a monthly basis, with the risk of not identifying and addressing longstanding work orders in a timely manner.
- The plant had recently started analysing the causes for leakages for all systems and components. However, at the time of the review, there were 150 leaks in Unit 3, and 70 were on safety related equipment.

Weaknesses in the work management system regarding work preparation, scheduling adherence and the minimization of maintenance backlogs can affect the availability and operability of safety related structures, systems and components (SSCs).

Recommendation: The plant should improve the work management system in order to improve work preparation, scheduling adherence, and minimize backlogs.

IAEA Basis:

SSR-2/2 (Rev.1) – Requirement 31: Maintenance, testing, surveillance and inspection programmes

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

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

8.14. Corrective maintenance of structures, systems and components shall be performed as promptly as practicable and in compliance with operating limits and conditions…….

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5.19. An appropriate system to manage and control backlogs of MTSI (Maintenance, Testing, Surveillance and Inspection) activities should be established to ensure that there are no adverse effects on the safety of the plant and that a backlog due to a lack of resources does not develop….

5.20. The effectiveness of the work planning and control system should be monitored using appropriate indicators (e.g. repeated work orders, individual and collective radiation doses, the backlog of pending work orders, interference with operations) and by assessing whether corrective action is performed as promptly as practicable.

5. TECHNICAL SUPPORT

5.6. PLANT MODIFICATION SYSTEM

During a review of the plant temporary modifications (TMs), it was identified that the plant process, procedures and practices to manage TMs did not ensure that TMs were limited in time and in number to avoid an additional burden for maintenance and operators. Furthermore, the cumulative safety significance of TMs was not minimized. The team found that while there was an expectation that TMs should not be in place for longer than 18 months and minimized wherever possible, there was no procedural framework to ensure the number and duration of TMs was limited. The team made a recommendation in this area.

The plant had established a process in which the permanent design modifications were integrated into a structured project management system. This process ensured that the plant's priorities were aligned in accordance with a graded approach based on safety and complexity. The process implemented at the plant ensured that the operational and design documentation always reflected the plant configuration, and the time to implement permanent modifications from initiation to completion had reduced. Additionally, the process prioritized the list of projects dynamically and periodically to align the entire organization (including resources) and allowed for the effective management of mitigation plans for any anticipated risks. The team identified this as a good practice.

5.6. PLANT MODIFICATION SYSTEM

5.6(a) Good Practice: Permanent design modifications were integrated into a structured project management system, ensuring that the plant's resources and requirements were all aligned and followed a graded approach based on safety and complexity.

Purpose

Development of a process for enabling permanent modifications to be integrated into a structured project management system which ensures that:

- The plant configuration is controlled at all times;
- A graded approach is taken so that resources are concentrated where necessary, and scheduling is optimized;
- Identified risks are controlled (for example, commissioning risks, scope, resources, quality, etc.);
- The project portfolio is managed in terms of scope, resources, scheduling, budget and risks;
- The system is sufficiently agile to control changes imposed by external factors (for example, new Safety Authority requirements, procurement issue, weather, etc.);
- All modifications are ranked by importance to safety.

Description

The following factors enabled the objective to be reached:

- A robust and effective process to manage permanent modifications using monitoring software (Synapse) that tracks updates to documents affected by the modification;
- An efficient process to identify, challenge and track minor modifications and maintain the design basis;
- A project management system based on international best practices, complying with the Project Management Institute's (PMI) standards;
- Permanent modifications integrated into the project process to ensure robust and rigorous control and monitoring based on a periodically updated dashboard (Project Health Report), and on a set of Key Performance Indicators (scope, scheduling, risk, resources, etc.). The dashboard can be used to update senior management on permanent modification progress;
- A system for prioritizing site projects to align departments and resources;
- The use of a single IT project management system common to the entire fleet.

Benefits

The system implemented at the Tihange plant resulted in the following benefits:

- has operational and design documentation that always reflects the plant configuration;
- manages and reduces the lifetime of permanent modifications from initiation to completion;
- prioritizes the list of projects dynamically and periodically in order to align the entire organization (including resources);
- anticipates risks effectively and manages their mitigation plans.

5.6 (1) Issue: The plant process, procedures and practices to manage temporary modifications (TMs) do not ensure that they are limited in time and in number in order to avoid an additional burden for maintenance and operators and thus to minimize cumulative safety significance.

During the review the team noted:

- The plant had an expectation that TMs should be in place for no longer than 18 months and minimized wherever possible. However, there were 68 TMs on Unit 3, five were from 2015 and 27 were more than 18 months old. In addition, 11 TMs were on safety systems, eight of them were more than 18 months old, five being implemented in 2015. In the last three years, the number has increased slowly, from 58 TMs in 2020 to 68 TMs in 2023.
- The plant does not have a target for limiting the number of TMs or a target to reduce the number of TMs.
- The plant does not have a person responsible for ensuring that the number of TMs is kept to a minimum.
- The plant did not have a KPI associated with the frequency for the re-authorization of TMs.
- The plant had not performed an evaluation to identify whether historical temporary modifications should be made into permanent modifications.

Without adequate processes, procedures and practices to minimize the number and limit the duration of TMs, additional burdens for maintenance and operators occurs and plant safety could be adversely affected.

Recommendation: The plant should enhance its processes, procedures and practices for managing TMs to limit their number and duration in order avoid additional burdens for maintenance and operations and to minimize their cumulative safety significance.

IAEA Bases:

SSR-2/2 (Rev.1) – Requirement 11: Management of modifications

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

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

6.4. Paragraph 4.41 of SSR-2/2 (Rev. 1) [1] states that "temporary modifications shall be limited in time and number to minimize the cumulative safety significance." To achieve this, any opportunity should be taken to remove temporary modifications as soon as possible, in particular during outages.

6.5 As noted in para. 6.4, a time limit is required to be specified for the removal of temporary modifications or for their conversion into permanent modifications. Justification should be provided if a temporary modification persists longer than its agreed duration and a new time limit should be specified.

6.9 The operating organization should regularly review temporary modifications and decide whether they are still needed. The review should check that associated operating procedures, instructions and drawings and operator aids conform to the approved configuration. The status of temporary modifications should be periodically reported (typically at monthly intervals) to the plant manager. Those that are considered to be needed permanently should be converted in a timely manner in accordance with the established procedure.

6.11 An appropriate procedure should be established to control temporary modifications on the plant. The following should be included in this procedure:

…

(g) The procedures for setting a time limit on temporary modifications and the procedure to extend this time limit, if necessary;

6. OPERATING EXPERIENCE FEEDBACK

6.2. THE MANAGEMENT SYSTEM AND THE ROLE OF MANAGEMENT

The plant had set up a specific organization for the management of operating experience (OE) consisting of operating experience managers and coordination managers who also act as special advisors to department heads on OE related matters. Their role was to support event owners during the process of analyzing event reports and provide mentoring on OE related matters to members of their department. They were also permanent members of the operating experience committees. The team recognized this as good performance.

6.3. IDENTIFICATION AND REPORTING

The plant used a single management tool for collecting events and operating experience (internal, external, fleet, international) with a coding system for annual trend analysis. However, the plant did not have a formal definition of a ‘near miss’. ‘Near-miss’ occurrences were recorded together with low-level events in operating experience condition reports without any clear identification. This makes it difficult to trend near-misses and to provide preventative actions to reduce the likelihood of more serious events from occurring. The team made a suggestion in this area.

6.7. CORRECTIVE ACTIONS

Depending on the significance of events and specific criteria, the plant carried out a root cause analysis in order to implement corrective actions aimed at preventing repeat events. An analysis of a sample of plant events showed that the plant applied a graded approach rather than systematically carrying out root cause or apparent cause analysis. Consequently, the plant misses the opportunity to identify event causes for a wider range of events and implement effective actions to avoid the potential recurrence of events. The team encourages the plant to review its application of the graded approach in the determination of which events should undergo root cause analysis to avoid the recurrence of repeated events.

In the CAP (Corrective Action Program), the plant had defined three priority levels for corrective actions. However, the plant had assigned the highest-level priority 1 actions to several long-timescale actions such as those associated with, for example, long-term operations. Furthermore, a number of these priority 1 long-term actions had been postponed several times which made it difficult for the plant to track the more immediate short-term priority 1 actions. The team encouraged the plant to clarify the way in which important and long duration actions are recorded and tracked within the corrective action programme.

DETAILED OPERATING EXPERIENCE FEEDBACK FINDINGS

6.3. IDENTIFICATION AND REPORTING

6.3 (1) Issue: The plant operating experience programme does not sufficiently allow the classification, trending and analyzing of 'near-miss' events in order to reduce the likelihood of more significant events occurring.

During the review the team noted:

- The definition of a 'near miss' event was not defined within the operating experience documentation.
- In the computational tool used by the plant (SAP) for collecting data related to activities, deviations and operating experience, there was no code to identify, track and trace 'near miss' events.
- From a manual screening of a sample of condition reports (not related to non-radiation-safety events), on Unit 3 from January 2022 to April 2023, the sample showed that there were other events, that should also have been classified as near miss events:
  - 300097672: Displaced temporary equipment
  - 300097674: Incorrect drainage alignment
  - 300097743: Dose rate set too high on dosimeter
  - 300098681: Foreign material: loss of passive dosimeter
  - 300099092: Inaudible emergency sirens in the administrative building
  - 300099626: Sensor found disconnected
  - 300099960: Material inappropriately stored inside a compartment within the radiologically controlled area
  - 300100683: Storage of oil drums without spillage collection
  - 300102100: Deviation in fire extinguisher management
- During the period from 2020 to 2022 the plant had three significant events associated with system alignment (REVE PORC 1/20/13, REVE PORC 2/22/10, REVE PORC 2/22/08) which might have been prevented if trending and analysis of near miss events had been carried out and preventive actions implemented.
- From a manual screening of a sample of condition reports on Unit 3 from January 2022 to April 2023, to determine if any event should have been classified as a non-radiation-safety "near-miss" event, eight out of 141 Event Operating Experience (FE) condition reports should have been classified as potential or dangerous situations or 'almost accidents.' For example:
  - 300097401: Potential injury due to tripping
  - 300098120 : Dangerous situation
  - 300097369: Risk of falling from a height
  - 300098977: Accident avoidance
  - 300100443: Work at height and non-compliance with safety rules
  - 300100971: Risk of falling from a height
  - 300101724: Work at height and non-compliance with safety rules
  - 300102105: Near miss road accident

Without a clear definition of 'near-miss' events the plant misses the opportunity to analyze underlying causes and implement preventive actions to avoid potential events with more significant consequences.

Suggestion: The plant should consider enhancing its arrangements for the classification, trending and analysis of 'near-miss' events in order to reduce the likelihood of more significant events from occurring.

IAEA Bases:

SSR-2/2 (Rev.1) – Requirement 24: Feedback of operating experience

5.31 The operating organization shall be responsible for instilling an attitude among plant personnel that encourages the reporting of all events, including low level events and near misses, potential problems relating to equipment failures, shortcomings in human performance, procedural deficiencies or inconsistencies in documentation that are relevant to safety.

SSG-50

2.23 Operating organizations should identify and feed into their operating experience programme all issues such as (a) events, including low level events and near misses; (b) potential problems relating to equipment and human performance; (c) safety related concerns; (d) situations that are likely to give rise to errors and need to be addressed to prevent undesired effects; (e) procedural deficiencies; and (f) inconsistencies in documentation. Opportunities for improvement and good practices that are relevant to safety should also be identified and fed into the programme.

2.27 The identification and reporting of low level events and near misses should be encouraged and included in the operating experience programme, since such events can provide valuable lessons to help avoid more significant events.

2.29 Individuals who report issues should receive feedback, due acknowledgement, and recognition from management to encourage future reporting. Good examples of reporting should be widely communicated within the installation to encourage future reporting and a questioning attitude.

7. RADIATION PROTECTION

7.2. RADIATION PROTECTION POLICY

Not all the results obtained during radiological surveys are easily accessible, as the computational tool used to register radiological data cannot retrieve historic dose rate values or area specific contamination values. Paper copies were kept in the archives but they are not easily accessible. Thus, it is difficult for radiological protection (RP) technicians to determine how radiological conditions may have changed due to different operational situations. The team encouraged the plant to review the way in which radiological records are managed to ensure they are more accessible.

7.3. RADIATION WORK CONTROL

The workplace monitoring programme, plant radiation protection practices and worker behaviors did not always ensure that contamination and radiation risks are minimized. Contamination control, surveillance and monitoring practices, did not always ensure that the contamination risk inside the Radiological Controlled Areas (RCA) were accurately determined and furthermore, there were no contamination detectors at the exit of the site. Some contaminated areas were not correctly monitored or identified and expectations to perform contamination controls or to wear protective equipment were not always well defined or well applied by workers. For work in high radiation areas, the Radiation Protection technicians were not required to be in permanent attendance and there were no specific instructions to check radiation meters before use. Dose rate alarm thresholds set in active dosimeters were not adjusted for each specific job and when dose rate alarms occurred, they were not analyzed or trended. The team made a suggestion in this area.

7.4. CONTROL OF OCCUPATIONAL EXPOSURE

The team noted that skin contamination dose calculations were only required when the high level alarm of the portal monitors activated, at a threshold of 5000 Bq. This practice could lead to a loss of skin dose contamination information. Additionally, there was no formal procedure to take into account the possible intakes of tritium (H3) and carbon 14 isotope (C14) for internal dose assessment. The team encouraged the plant to revise the criteria for which skin dose calculations were performed and to develop a procedure for H3 and C14 dose intakes to ensure that all dose exposures are correctly assessed.

7.6. RADIOACTIVE WASTE MANAGEMENT AND DISCHARGES

The plant used a robot to process highly radioactive waste to prevent significant personnel dose exposure. The process to remotely separate, sort, cut and compact radioactive waste had resulted in a significant reduction in the volume of highly radioactive waste. The team recognized this as a good performance.

7.3. RADIATION WORK CONTROL

7.3 (1) Issue: The radiation workplace monitoring programme, plant radiation protection practices and worker behaviours do not always ensure that contamination and radiation risks are minimized.

During the review the team noted:

- The procedure for airborne contamination control during an iodine injection operation was not correctly followed by the worker nor checked by the RP technician. The airborne contamination sampler was positioned in an adjacent room and not in the work location. The reason stated was that the only available power supply was in an adjacent room and no attempt was made to obtain an electrical extension cable to enable the airborne sampler to be positioned at the work location.
- During an activity to fix a leak on valve CCV-458 from the Chemical and Volume Control System (CVCS) with work permit DDC-3908601, there was no clear requirements nor clear demarcation defining the point at which masks should be worn. The personnel who were performing the undressing of the workers who had carried out the task, entered the room where the valve was located without their masks and only wore them during the undressing process.
- The contaminated area DE-203 in the spent fuel building for intermediate waste storage had two access points. One was correctly identified as a contaminated area and had the mandatory step-over barrier, whilst the other access point had no indications or step-over barrier.
- During a plant walkdown, the expectations to check for hand and foot contamination at the exit of the hot decontamination workshop and maintenance tooling store in the RCA (C0 barrier) were not clearly explained and there were no clear instructions on when the hand and foot contamination monitors should be used.
- At the site exit there were no personal contamination monitors or vehicle contamination detectors. The plant only had gamma detectors placed at a distance from walkways and driveways to detect abnormal radiological dose conditions.
- The plant had two contamination control barriers, C1 and C2, with portal monitors at the exit from the Radiation Controlled Area (RCA), and an additional barrier C0 near the areas where contamination risk was higher to protect against the spread of contamination. Handwashing was required before the C1 monitors. However, the practice of handwashing before C1 portal monitors prevents the detection of hand contamination at the C1 portal monitor.
- The contamination rate results obtained at the C2 portal monitors were represented in a KPI for the plant. However, there is no defined indicator for the contamination rate results obtained at the C0 or C1 portal monitors.
- An RP technician performed a contamination survey in room YL054, classified as a non-contaminated area. The RP technician checked the contamination in the main corridor but not in the areas below the valves where contamination was more likely. They did not notice a boron leak, and when this was pointed out, a smear test was performed on the leak, and it showed slight contamination. No immediate reclassification or remedial actions were performed by the technician as they had to be discussed with the foreman before any action could be taken.
- During work in high radiation areas or potentially high radiation areas, the radiation workplace monitoring programme did not require permanent supervision by Radiation

Protection (RP) technicians. An RP check had to be performed at the start and every two hours according to the site procedure.

- Radiation meters used for radiological surveillance were checked on a yearly basis and were calibrated only if the results were not within the accepted values. There was no requirement for a functional test before use.
- Dose rate alarm thresholds set in active dosimeters were not adjusted for each specific job in the RCA, with one common value used during normal operation and another value for the outage. In addition, dose rate alarms were not analyzed or trended.

Without an effective workplace monitoring programme as well as robust plant protection practices and adequate worker awareness, the contamination and radiation risks may not be minimized.

Suggestion: The plant should consider enhancing its radiation workplace monitoring programme as well as radiation protection practices and worker awareness to ensure that contamination and radiation risks are minimized.

IAEA Bases:

SSR-2/2 (Rev.1) – Requirement 20: Radiation protection

5.11. The radiation protection programme shall ensure that for all operational states, doses due to exposure to ionizing radiation at the plant or doses due to any planned radioactive releases (discharges) from the plant are kept below authorized limits and are as low as reasonably achievable.

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. Consequently, particular emphasis shall be given to the training of all site personnel so that they are aware of radiological hazards and of the necessary protective measures.

GSR Part 3:

3.88. Registrants and licensees shall designate as a controlled area any area...in which specific measures for protection and safety are or could be required for:

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

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

3.90. Registrants and licensees:

(d) Shall establish measures for protection and safety, including, as appropriate, physical measures to control the spread of contamination and local rules and procedures for controlled areas.

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

(a) Shall establish in writing local rules and procedures that are necessary for protection and safety for workers and other persons

(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;

GSG-7:

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;

(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.

3.105. The equipment to be used in the monitoring programme should be suitable for the types of radiation and the forms of radioactive material encountered in the workplace. The equipment should be calibrated to meet appropriate standards.

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

9.28. Work in contaminated areas should be conducted in a manner that minimizes the spread of contamination to adjacent surfaces, to individuals in the area and to the workplace atmosphere. To control the spread of contamination and to restrict individual exposures, provisions, such as the erection of physical barriers (with changing of footwear) and cordoning off affected areas, should be made in and around contaminated areas.

9.29. Control of access to contaminated areas may be necessary to ensure that workers entering the area are informed of the radiological status and potential hazards and, if necessary, are provided with the appropriate personal protective equipment. Visual display of the levels of contamination and caution boards should be prominently displayed. The workers' exit from contaminated areas should be controlled to ensure that radioactive substances are not inadvertently transferred from the area by personnel or on equipment. Efforts should be made to control the degree of contamination and the size and number of contaminated areas within a facility.

RS-G-1.8:

9.5. More specifically, the quality assurance programme should cover:

(a) The design and implementation of monitoring programmes, including the selection of suitable equipment, sampling locations and procedures and their documentation;
(b) The proper maintenance, testing and calibration of equipment and instruments to ensure that they function correctly;
(c) The use of calibration standards that are traceable to national or international standards;…..

8. CHEMISTRY

8.1. ORGANIZATION AND FUNCTIONS

The plant's cooperation and operating experience exchange with on-site and off-site organizations ensures that chemistry procedures are kept in line with the best industry practices. The team recognizes this as a good performance.

8.3. MANAGEMENT OF CHEMISTRY DATA

The plant did not have a common plant chemistry data system to capture data from on-line chemistry monitoring as well as from the manual chemistry laboratory data. This makes it difficult to evaluate and trend main chemical parameters, and to respond to correct small deviations, adverse trends, or fast chemistry parameter transients. The team encourages the plant to improve its management of chemistry data to avoid potential delays in taking corrective actions.

8.4. CHEMISTRY SURVEILLANCE AND CONTROL PROGRAMME

The plant had adopted a new approach for the chemistry surveillance and control of lubricating oil systems and diesel fuel systems which ensured the high quality of lubricating oils and diesel fuels. The team recognized this as good performance.

8.6. QUALITY CONTROL OF OPERATIONAL CHEMICALS AND OTHER SUBSTANCES

The plant had arrangements for the storage and labelling of operational chemicals and other substances. However, the team observed examples where plant procedures and practices for storage and labelling of operational chemicals and other substances did not always follow these arrangements. There were examples of improper storage of chemicals and other substances, missing information about the shelf life of chemicals and out-of-date chemical risk pictogram labels. The team made a recommendation in this area.

8.6. QUALITY CONTROL OF OPERATIONAL CHEMICALS AND OTHER SUBSTANCES

8.6 (1) Issue: The plant procedures and practices for the storage and labelling of operational chemicals and other substances are not always sufficiently applied and controlled to ensure safe and proper use of operational chemicals and other substances in the plant.

During the review, the team noted:

- A toxic chemical (methanol) was stored in a cabinet which was not marked with a toxic hazard symbol in cold laboratory XL 327.
- The extracts from the Material Safety Data Sheets (risk information, hazard statements, safety information and precaution statements) were not updated in the mechanical workshop and in plant document CHIRAD/00/028 (Handling and storage of chemicals in laboratories), which was not in accordance with the plant policy and procedures for the storage of chemicals.
- A white bag with no labelling and containing an unknown powder (approximately three kg) was observed in the severe accident mobile equipment storage room.
- The risk pictograms labels and extracts from the Material Safety Data Sheets, were not updated on the 40 m^3 tank containing 34% hydrochloric acid (HCl) or on the 40 m^3 tank containing 50% sodium hydroxide (NaOH) in room F305.
- The risk pictograms labels had not been updated on chemicals stored in the mechanical workshop or in the hot laboratory.
- The risk pictogram label had not been updated in the auxiliary building near component cooling system water tank CRI-B44 in room N504.
- The expiry dates for the chemical Bio X (two 20-litre containers), the chemical Metal DR 150 (20-litre container) and the chemical Hydran LB 46 (2-litre container and 1-litre bottle) stored in the mechanical workshop were missing, and according to plant policy and procedures for storage of chemicals, the expiry date was required to be displayed on these containers.
- Two canisters of leak detection fluid were found on the ground inside cage CAM V480.
- The plant identified that seven percent of the total number of incidents reported in 2022 were associated with contact with chemicals.

Without effective, safe and proper storage and labelling of operational chemicals and other substances, there is an increased risk that the use of operational chemicals and other substances could adversely affect plant operations.

Recommendation: The plant should enhance the application and control of its procedures and practices for the storage and labelling of operational chemicals and other substances to ensure safe and proper use of operational chemicals and other substances in the plant.

IAEA Bases:

SSR-2/2 (Rev.1) – Requirement 29: Chemistry programme

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

SSG-13

9.2. The operating organization should be responsible for the use of the proper chemicals and for their correct quality.

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.

9.13. Management should periodically carry out walkdowns of the plant to evaluate the effectiveness of the chemistry programme and to check for uncontrolled storage of chemicals.

9. EMERGENCY PREPAREDNESS AND RESPONSE

9.1. ORGANIZATION AND FUNCTIONS

There was a high level of cooperation and communication between plant and external organizations and off-site authorities involved in the emergency response (for example, civil protection, external fire brigade, provincial crisis center and national crisis center). During normal operation or in case of an emergency, the plant could use equipment and resources provided by the external fire brigade and civil protection, such as fire engines and first responders. The team recognized this as good performance.

9.2. EMERGENCY RESPONSE

The plant had arrangements in place for the transition and recovery phases after the termination of a design basis radiological accident, but these arrangements were not sufficiently robust to ensure that all related measures were adequately established at the plant. For example, the roles and functions of organizations after the end of the first emergency phase were not defined. The transition and recovery phases hazard assessments, and the impact on human resources, including contractors were not defined. In addition, there was no guidance within the emergency plan for the operational intervention levels for the transition and recovery phases, no pre-established locations on the site for the collection of any contaminated liquid waste and soil, and no guidance for the management of radioactive waste. The team made a suggestion in this area.

The plant had arrangements to provide an urgent medical response and medical treatment for those individuals who were contaminated on the site. However, the team found weaknesses in these arrangements, for example, there was no requirement for the medical duty team to be physically onsite in the event of a radiological emergency with site contamination. Furthermore, the medical duty team were responsible for carrying out medical decontamination, however, the pre-established decontamination point was not equipped with the appropriate decontamination equipment. The team made a suggestion in this area.

During non-working hours, the plant notification system for the on-call duty emergency teams notified some of the emergency workers (managers) via the mobile phones and the secure country-wide paging system (ASTRID pagers). However, the technicians and medical staff were only notified via their mobile phones. In addition, only mobile phones were used as the notification system for the backup emergency teams. The team encouraged the plant to provide diverse communication devices for all the emergency workers included within the plant emergency organization.

9.3. EMERGENCY PREPAREDNESS

The plant had not conducted exercises for the collection and transportation of the backup emergency response team to the plant. Furthermore, the plant had not tested the handover arrangements between first responders and the backup emergency teams. The team encouraged the plant to conduct exercises and test handovers between first responders and the backup emergency teams.

9. DETAILED EMERGENCY PREPAREDNESS AND RESPONSE FINDINGS

9.2. EMERGENCY RESPONSE

9.2 (1) Issue: The plant arrangements for the transition and recovery phases after the termination of a design basis radiological emergency which has impact on the plant territory are not sufficiently robust to ensure that all necessary on-site measures are adequately established.

During the review the team noted:

- The plant emergency plan does not include any of the functional aspects related to the transition and recovery phases after the termination of a design basis emergency which has an impact on the plant territory.
- The plant does not have pre-determined and pre-established arrangements for the transition and recovery phases after the termination of the emergency in its emergency plan such as:
  - the roles and functions of organizations after the end of the first emergency phase;
  - hazard assessments for transition and recovery phases;
  - the participant organizations for the recovery phase;
  - the human resource requirements, including the provision of contractors;
  - the financial provision;
  - the logistic support for all activities;
  - the location of the new recovery phase emergency organization;
  - the radiation controls of contaminated areas within the plant perimeter;
  - the operational intervention level (OIL) for transition and recovery phase;
  - the reference levels, generic criteria, operational criteria and dose limits for recovery emergency workers;
  - the relevant pre-requisites for the transition to either an existing exposure situation or a planned exposure situation;
  - the pre-established site locations for the collection of liquid waste and soil;
  - the management of the radioactive waste;
  - the provision of training and drills for on-site teams involved in the transition and recovery phases.

Without effective arrangements in place for the transition and recovery phases after the termination of a design basis radiological emergency, the plant capabilities for an effective site response for an extended period following the emergency event may be compromised.

Suggestion: The plant should consider establishing appropriate arrangements for the transition and recovery phases after the termination of a design basis radiological emergency which has impact on the plant territory, to ensure that all necessary on-site measures are adequately established.

IAEA Bases:

SSR-2/2 (Rev.1) – Requirement 18: Emergency preparedness

5.4. The emergency plan shall cover all activities under the responsibility of the operating organization and it shall be adhered to in the event of an emergency. The emergency plan shall include arrangements for an emergency involving a combination of non-radiological hazards and radiological hazards, such as a fire in conjunction with significant levels of radiation or contamination, or toxic or asphyxiating gases in conjunction with radiation or contamination. Account shall be taken in the emergency plan of the specific site conditions. Preparation of the emergency plan shall be coordinated with those bodies having responsibilities in an emergency, including public authorities and private enterprises, as relevant, and the plan shall be submitted to the regulatory body as required. The plan shall be subject to review and updating in the light of experience gained.

GSR Part 7

4.16. The operating organization shall establish and maintain arrangements for on-site preparedness and response for a nuclear or radiological emergency for facilities or activities under its responsibility, in accordance with the applicable requirements (see paras 1.12, 4.5 and 4.12).

4.17. The operating organization shall demonstrate that, and shall provide the regulatory body with an assurance that, emergency arrangements are in place for an effective response on the site to a nuclear or radiological emergency in relation to a facility or an activity under its responsibility.

5.95. Adjustment of protective actions and other response actions and of other arrangements that are aimed at enabling the termination of an emergency shall be made by a formal process that includes consultation of interested parties.

5.99. The transition to an existing exposure situation or to a planned exposure situation shall be made in a coordinated and orderly manner, by making any necessary transfer of responsibilities and with the increased involvement of relevant authorities and interested parties.

5.101. Once the emergency is terminated, all workers undertaking relevant work shall be subject to the relevant requirements for occupational exposure in planned exposure situations, and individual monitoring, environmental monitoring and health surveillance shall be conducted subject to the requirements for planned exposure situations or existing exposure situations, as appropriate.

GSG-11

3.9. Before any decision to terminate the emergency is made, a thorough hazard assessment should be performed in respect of the situation and its future development, consistent with Requirement 4 of GSR Part 7 [2]. The hazard assessment should provide a basis for preparedness and response for any new emergency that may occur.

3.13. The radiological situation should be assessed, as appropriate, against reference levels, generic criteria, operational criteria and dose limits, to determine whether the relevant prerequisites for the transition to either an existing exposure situation or a planned exposure situation, as appropriate, have been achieved.

4.7. The authority, roles and responsibilities of all organizations with regard to preparation, response and recovery in the transition phase — including oversight of the implementation of provisions within the legal and regulatory framework, as well as ensuring the necessary resources (human, technical and financial) — should be identified at the preparedness stage. The identification of these elements should be based on the activities that are expected to be carried out during the transition phase to fulfil the prerequisites set out in Section 3. As part of these arrangements, the authority and responsibility for making a formal decision on the termination of a nuclear or radiological emergency should be clearly allocated, well understood and documented in the respective emergency plans and procedures. Consideration should be given to the fact that the organization with the authority and responsibility for deciding on the transition from an emergency exposure situation to an existing exposure situation or a planned exposure situation may differ between the on-site areas and off-site areas.

4.11. With the formal termination of the emergency, the structure of the emergency response organization should be deactivated. At that stage, the management structure of the various response organizations should revert to what it had been prior to the emergency to allow for an effective response to any emergency that might occur in the future; however, some of these organizations may need to assume additional responsibilities. There may also be a need for new coordination and consultation mechanisms for those organizations dealing with the consequences of the emergency in the longer term as an existing exposure situation or a planned exposure situation.

9.2 (2) Issue: The plant process and procedures related to the provision of urgent protective measures, and the management of the medical response to contaminated or potential overexposed individuals do not always ensure the safety of plant personnel during radiological emergencies.

During the review the team noted:

Medical response:

- The site medical duty team were not required to be physically present on-site in the event of a radiological emergency resulting in site or personnel contamination.
- The mobile network was the only out-of-hours means of communication between the medical duty team and the radiological leader (R6). Consequently, in the event of a loss of communications (mobile network not functioning), there could be a delay in the consultation between the medical staff and the radiological leader (R6) regarding the urgent protective actions to be taken such as the taking of potassium iodide tablets (KI).
- In the medical service storage room, decontamination liquids were found that had gone beyond their expiry date, for example, 15 x 1L bottles of three percent citric acid solution, 26 x 1L bottles of four percent potassium solution KMNO4 (expiry date 22 October 2022), 100 x 100ml of 'Solopol' cream (expiry date 25 September 2022). A member of the medical service team stated that the use of these out-of-date products could be hazardous for human health.
- The doctors from the external medical service had not received training on the plant emergency plan and their roles and responsibilities in the event of a radiological emergency including the knowledge of the decontamination process and the process for potassium iodine tablet (KI) distribution.

Decontamination process:

- The main Emergency Response Centre (ERC) was not sufficiently equipped to undertake the decontamination of contaminated personnel. For example, there was no installed running water, sanitation, shower, toilets or system for collecting contaminated water.
- The medical decontamination service room was located in the basement of the administrative building, but this room was not equipped with the appropriate decontamination equipment such as special filtered ventilation system, shower, backup electricity, dosimetry equipment and system for collection of contaminated water.
- The plant had one on-site decontamination location outside the technical perimeter for use during radiological emergencies. It was located at the entrance of the Backup Emergency Response Centre (BERC). The decontamination area within the BERC was very small, 13 m^2 in size and was not adequately equipped for decontamination (no installed running water, sanitation, shower, toilets and system for collecting contaminated water).

Application of Urgent Protective Measures:

- The plant had a contract with a transport company for the evacuation of plant personnel. The arrival time of the buses was two hours. In case of a fast release emergency, there could be a delay in the evacuation of plant staff which could result in some personnel becoming contaminated. In addition, the plant did not have contamination monitors installed at the exit of the site.

Without clearly established plant process and procedures for taking urgent protective measures, the potential for the plant to adequately protect personnel and emergency workers in the event of a radiological emergency may be compromised.

Suggestion: The plant should consider enhancing the process and procedures related to the provision of urgent protective measures and for the management of the medical response to contaminated or potentially overexposed individuals to ensure the safety of plant personnel during radiological emergencies.

IAEA Bases:

SSR-2/2 (Rev.1) – Requirement 18 Emergency preparedness

5.2. Emergency arrangements shall cover the capability of maintaining protection and safety in the event of an accident; mitigating the consequences of accidents if they do occur; protection of site personnel and the public; protection of the environment; coordinating response organizations, as appropriate; and communicating with the public in a timely manner [1, 6]. Emergency arrangements shall include arrangements for: the prompt declaration of an emergency; timely notification and alerting of response personnel; assessment of the progress of the emergency, its consequences and any measures that need to be taken on the site; and the necessary provision of information to the authorities…..

GSR Part 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.

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

5.39. Within the emergency planning zones and emergency planning distances, arrangements shall be made for taking appropriate protective actions and other response actions effectively, as necessary, promptly upon the notification of a nuclear or radiological emergency. These arrangements shall include arrangements for:

(a) Prompt exercise of authority and discharge of responsibility for making decisions to initiate protective actions and other response actions upon notification of an emergency (see para. 5.12);

(b) Warning the permanent population, transient population groups and special population groups or those responsible for them and warning special facilities;

(c) Taking urgent protective actions and other response actions such as evacuation, restrictions on the food chain and on water supply, prevention of inadvertent ingestion, restrictions on the consumption of food, milk and drinking water and on the use of commodities, decontamination of evacuees, control of access and traffic restrictions;……

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.

5.64. Arrangements shall be made so that, in a nuclear or radiological emergency, individuals with possible contamination can promptly be given appropriate medical attention. These arrangements shall include ensuring that transport services are provided where needed and providing instructions to medical personnel on the precautions to take.

5.65. For facilities in categories I, II and III, arrangements shall be made to manage an adequate number of any individuals with contamination or of any individuals who have been overexposed to radiation, including arrangements for first aid, the estimation of doses, medical transport and initial medical treatment in predesignated medical facilities.

10. ACCIDENT MANAGEMENT

10.1. ORGANIZATION AND FUNCTIONS

The scope and the assessment of personnel on Severe Accident Management training, exercises and drills was not sufficient to demonstrate an adequate level of knowledge and proficiency in the application of the severe accident management guidelines at the plant. The team made a suggestion in this area.

10.4. DEVELOPMENT OF PROCEDURES AND GUIDELINES

Strategies for the recovery phase following a severe accident, which commences after the plant had been returned to a controlled stable state, had been designed and put in place by the plant and there were procedures for their implementation. The team recognized this as a good practice.

The plant accident management programme documentation did not ensure that revisions to the basis information were applied and that the revised guides were validated to ensure that the guidance available was optimized for the mitigation of a severe accident at the plant. The team made a suggestion in this area.

The plant had developed line-diagrams for the Severe Accident Management Guideline (SAMG) strategies based on system Piping and Instrumentation Diagrams (P&ID) that aid the reliable implementation of severe accident management strategies. The team recognized this as a good performance.

10.5. PLANT EMERGENCY ARRANGEMENTS WITH RESPECT TO SAM

The plant had installed an alternate containment spray system as a backup to the containment spray which reduces the likelihood of needing to use the containment filtered ventilation system to protect the containment building from over pressurization. To protect the containment building from basemat failure (failure of the reinforced concrete under the reactor vessel), the plant had also installed a reactor pit flooding system. The use of these additional systems was documented and trained. The team recognized this as good performance.

DETAILED ACCIDENT MANAGEMENT FINDINGS

10.1. ORGANIZATION AND FUNCTIONS

10.1 (1) Issue: The scope and assessment of personnel undertaking Severe Accident Management training, exercises and drills are not sufficient to demonstrate an adequate level of knowledge and proficiency in the application of the severe accident management guidelines at the plant.

The team noted the following:

- The initial and refresher training for the main users of the Severe Accident Management Guidelines (SAMGs) (Safety Engineers and Operations Engineers) had no assessment to confirm their knowledge and proficiency.
- The initial and refresher training for ultimate decision makers for implementing SAMG actions (R1 and R2) had no assessment to confirm their knowledge and proficiency.
- The Main Control Room (MCR) personnel SAMG initial training material had no assessment questions to confirm their knowledge and proficiency.
- MCR personnel SAMG refresher training had no practical exercises or assessment questions to confirm their knowledge and proficiency.
- There were no Emergency Preparedness (EP) drill evaluation criteria, for evaluating the knowledge and proficiency of the SAMG users.
- The practical training on the use of the pit injection and backup containment spray (IPCA), used on-job-training (OJT) but had no task-performance-evaluation criteria (TPE) to confirm proficiency.
- There had been no multi-unit severe accident tabletop exercises.
- There had been no multi-unit severe accident drills.
- There was no drill during 2022 where the criteria for entry into the SAMGs was met even though having one severe accident drill per calendar year for the plant was a documented requirement.

Without adequate scope and assessment of personnel undertaking Severe Accident Management training, exercises and drills, the effective implementation of the SAMG might be compromised.

Suggestion: The plant should consider improving the scope and the assessment of personnel undertaking Severe Accident Management training, exercises and drills to ensure an adequate level of knowledge and proficiency in the application of the Severe Accident Management guidelines at the plant.

IAEA Bases:

SSR-2/2 (Rev.1) – Requirement 4: Staffing of the operating organization

3.11: The organization, qualifications and number of operating personnel shall be adequate for the safe and reliable operation of the plant in all operational states and in accident conditions..….

Requirement 19: Accident management programme

5.8E. The accident management programme shall include training necessary for implementation of the programme.

5.9. Arrangements for accident management shall provide the operating staff with appropriate competence, systems and technical support…..

SSG-54

2.96: Adequate staffing levels and personnel qualifications should be established for the implementation of accident management measures, taking into account (a) the possibility that all units can be affected concurrently by simultaneous accidents and (b) the requirements for emergency response (see GSR Part 7 [7]).

3.114: Training should cover severe accidents occurring simultaneously at more than one unit….

4.8: The staff responsible for the execution of severe accident management measures should be adequately qualified ………...

GS-G 3.1

4.9: The organization's training plan should include:

…..Measurement of the transfer of knowledge (questionnaire, diploma, qualification, accreditation, assessment)

…An evaluation of the effectiveness of the training, including individual performance, the performance results of the organization carrying out the training, and the training process.

4.19: Periodic requalification should be required, to demonstrate that individuals continue to be capable of performing their assigned tasks.

SSG-75

3.6: Appropriate records of assessments against criteria for competence and qualification should be established and maintained for each individual at the plant.

4.16: Training should be carefully controlled and structured to achieve the training objectives in a timely and efficient manner. The following training settings and methods should be considered:

(b) On the job training should be conducted in accordance with guidelines developed by experienced personnel who have been trained to deliver this form of training. Progress should be reviewed, and assessments should be performed by an independent assessor.

4.20: The importance of training by means of simulators and computer based systems should be emphasized in order to develop human–machine interface skills.

4.21: All progress made in training should be assessed and documented. The means of assessing a trainee's ability include written examinations, oral questioning and performance demonstrations. A combination of written and oral examinations has been found to be the most appropriate form of demonstrating knowledge and skills.

4.46: The operating organization should maintain adequate documentation of the training of individuals (including on the job training) and of the performance of individual trainers and trainees (including a list of main activities performed). The documentation should include (or at least provide a reference to) learning objectives, lesson and exercise plans, student reading material, guidance for on the job training, and documentation on instructors and assessors. The aims of this documentation should be as follows:

(c) To enable managers to deploy personnel effectively, ensuring that only suitably qualified and experienced personnel are assigned to safety related activities;

10.4. DEVELOPMENT OF PROCEDURES AND GUIDELINES

10.4(a) Good Practice: Strategies for the stabilization of the reactor core following a severe accident resulting in a core melt have been designed and put in place by the plant and there were procedures for their implementation.

Purpose

The aim of the strategies for the stabilization of the reactor core was to facilitate actions during the phase following a severe accident. The strategies which have been developed can be applied after the plant has been returned to a controlled stable state and can continue for many years.

Description

The plant had evaluated the phase following a severe accident which resulted in a number of plant modifications to enable:

- Back flushing of the containment filtered ventilation system (CFVS) using a mobile pump.
- Refurbishing (refilling with water and appropriate chemicals) of the CFVS to support repeated use, using a mobile chemical supply unit.
- Chemical addition into the containment building via the spray system. The system consists of a mobile pump fed by a truck containing sodium hydroxide (NaOH).

These actions have been formally documented in the guidelines, procedures and Piping and Instrumentation Diagrams (P&IDs).

Figure 1: Injection points for Backflushing (or refilling the CFVS) and NaOH injection into Containment Building

Benefits

- Backflushing the CFVS transfers contaminants back into containment. The filtered vent is outside of the 3rd fission product barrier and so transferring this radioactivity back into containment is of benefit to longer term accident management.
- Following a severe accident, it is credible that repeated use of the CFVS may be required. Being able to backflush and then refurbish the filter with additional water and chemicals enables repeated use.

- Being able to inject NaOH enables the control of pH of the water inside containment which may be necessary because of the creation of various acids during a severe accident. This action minimizes corrosion and the spread of Iodine (I_2) from out of the containment sump.

10.4 (1) Issue: The plant accident management programme documentation does not ensure that revisions to the SAMGs basis information are evaluated and implemented and that the revised SAMGs are validated in a timely manner, to ensure that the guidance available is optimized for the mitigation of a severe accident at the plant.

The team noted the following:

- The validation of the SAMGs occurred in 2010. Since then, eight SAMGs (with associated background documents) have been developed (or extensively changed) and issued to the plant, without formal validation. These guidelines included those for: hydrogen control, loss of DC power and accidents initiated from shutdown conditions.
- The Pressurized Water Reactors Owners Group (PWROG) sends out updates to SAMGs and it was the responsibility of the plant to determine the applicability of the updates. However, there was no formal process for evaluating and implementing proposed updates and the plant staff had no formal training or qualification for this role.
- The Operating Experience (OE) database was used by the plant to capture and progress external requests to update documentation. However, the OE database was not used to track PWROG SAMG updates as the OE database had nine PWROG items, but none of these were for SAMG updates.
- The PWROG SAMG Direct Work (SDW) requests for changes to SAMGs (such as for recovering fuel located in the refuelling cavity) had been received by the plant but they had not been formally evaluated for applicability.
- The US PWROG February 2016 version (PWROG-15015) of the generic SAMGs include the following guidelines that were not available at Tihange Unit 3:
  - TSG-1 Instrumentation
  - TSG-2 Decision Maker Guideline
  - TSG-3 Site Capabilities
  - DPG Diagnostic Process Guide
- Similarly, the above guides were issued by the International PWROG in December 2016 (PWROG-16059) but they were not included in the Tihange Unit 3 SAMGs although the need for these changes was evaluated and documented but they were not implemented.
- There was an item in the OE database from 2008 where PWROG updates to operating procedures were not getting through to the correct person at Doel NPP. This was resolved by assigning the corporate office (Tractebel) to collect the relevant information and provide to both Tihange and Doel NPP for evaluation and implementation any PWROG updates to operating procedures. This process was demonstrably working for PWROG operating procedures updates at Tihange but not for SAMGs updates.

Without a documented process for assessing revisions to the SAMGs basis information and for validating the Severe Accident Management Guidelines, the guidance available may not be optimized for the mitigation of a severe accident at the plant.

Suggestion: The plant should consider updating the plant accident management programme documentation to ensure revisions to the SAMGs basis information are evaluated and implemented and the revised guides are validated in a timely manner to ensure that the guidance available is optimized for the mitigation of a severe accident at the plant.

IAEA Bases:

SSR-2/2 (Rev.1) – Requirement: 19 Accident management programme

5.8 ….The accident management programme shall be documented and shall be periodically reviewed and as necessary revised.

SSG-54

2.48 The overall form of the guidelines and the selected level of detail should be evaluated during validation of the guidelines and then tested in exercises. On the basis of such exercises, it should be judged whether the form is appropriate and whether additional detail should be included in the SAMGs. Exercises should enable identification of areas for improvement

2.56 Verification and validation processes should assess the technical accuracy and adequacy of the accident management guidance to the extent possible, as well as the ability of personnel to follow and implement this guidance.……The validation process should demonstrate that the necessary instructions are provided to implement the guidance.

2.58 The findings and insights from the verification and validation processes, including consideration of positive and negative consequences of actions, should be documented. This information should be used to provide feedback to the developers of procedures and guidelines for any necessary updates before the documents are brought into force by the management of the operating organization. The documentation should be stored appropriately to enable any future revalidation.

3.2 Six main steps should be executed to set up and develop a severe accident management programme…..

(5) Establishment of a verification and validation process for the severe accident management programme……

3.61 Verification and validation processes should assess the technical accuracy and adequacy of the SAMGs and background documents to the extent possible, as well as the ability of personnel to follow and implement them…… The validation process should demonstrate that the necessary instructions are provided to implement the guidance.

3.62 Validation tests should address the organizational aspects of severe accident management, especially the roles of the evaluators and decision makers, including the staff in the main control room and in the technical support centre.

3.63 Changes made to procedures and guidelines should be re-evaluated and revalidated on a periodic basis to maintain the adequacy of the severe accident management programme.

3.66 Validation should be performed under conditions that realistically simulate the conditions present during an emergency and should include simulation of other response actions, hazardous work conditions, time constraints and stress. Special attention should be paid to the use of portable and mobile equipment, when such use is considered, and for multiple unit sites, to the practicality of using backup equipment that could be provided by other units.

3.118 The need to update the severe accident management programme should be assessed as new information becomes available that may indicate the potential for new accident scenarios, phenomena or challenges to physical barriers or any other significant effect on accident management that had not been fully considered previously.

3.120 When modification of the severe accident management programme is deemed appropriate, the operating organization should be responsible for establishing an action plan aimed at prioritizing the activities necessary for implementation of the modifications. When a generic severe accident management programme is used, the development of the action plan should involve the vendor of the generic programme. The action plan should identify the time frame and the organization in charge of the practical implementation of the modifications.

3.122 New insights from research on severe accident phenomena and operating experience at the plant and at other plants (including lessons identified from events) should be evaluated on a regular basis, and a judgement should be made by the operating organization as to their potential impact on the severe accident management programme. The exchange of information with operating organizations of other plants should be used as a means of continuously improving the severe accident management guidance.

SUMMARY OF RECOMMENDATIONS AND SUGGESTIONS AND GOOD PRACTICES

AREAS	RECOMMENDATIONS & SUGGESTIONS & GOOD PRACTICES
LMS	**Suggestion:** The plant should consider improving its ability to identify non-radiation-related-safety hazards and reinforce the compliance with non-radiation-safety rules and practices to prevent incidents and events.
TQ	**Recommendation:** The plant should enhance the design, operating parameters and operational capability of the full scope simulator to sufficiently replicate the Unit 3 main control room, ensuring operators can train the practical skills required for the safe operation of the plant. **Suggestion:** The plant should consider enhancing the implementation of the systematic approach to training processes for trainee evaluation and training material quality assurance to ensure trainees have the required competencies for safe plant operations.
OPS	**Good Practice**: The plant has developed an integrated tool to support fire hazard analyses which includes assessments for the fire resistance of fire separation barriers, calculations for fire propagation in multi-compartment configurations and an algorithm for taking extinguishing systems into account in the calculation of fire growth and propagation. **Suggestion:** The plant should consider enhancing its arrangements for the management of unauthorized operator aids to ensure the correct identification and maintenance of equipment. **Recommendation:** The plant should improve its expectations for the identification and reporting of material condition, labelling, foreign material and housekeeping deficiencies during field operator walkdowns.
MA	**Good practice:** The plant had developed a system called 'WESTI' to track mobile equipment and low-level radioactive waste and to aid the management of storage areas and associated fire loads. **Recommendation:** The plant should improve the work management system in order to improve work preparation, scheduling adherence, and minimize backlogs.
TS	**Good Practice**: Permanent design modifications were integrated into a structured project management system, ensuring that the plant's resources and requirements were all aligned and followed a graded approach based on safety and complexity. **Recommendation:** The plant should enhance its processes, procedures and practices for managing TMs to limit their number and duration in order avoid additional burdens for mainteance and operations and to minimize their cumulative safety significance.

OEF	**Suggestion:** The plant should consider enhancing its arrangements for the classification, trending and analysis of 'near-miss' events in order to reduce the likelihood of more significant events from occurring.
RP	**Suggestion:** The plant should consider enhancing its radiation workplace monitoring programme as well as radiation protection practices and worker awareness to ensure that contamination and radiation risks are minimized.
CH	**Recommendation:** The plant should enhance the application and control of its procedures and practices for storage and labelling of operational chemicals and other substances to ensure safe and proper use of operational chemicals and other substances in the plant.
EPR	**Suggestion:** The plant should consider establishing appropriate arrangements for the transition and recovery phases after the termination of a design basis radiological emergency which has impact on the plant territory to ensure that all necessary on-site measures are adequately established. **Suggestion:** The plant should consider enhancing the process and procedures related to the provision of urgent protective measures and for the management of the medical response to contaminated or potentially overexposed individuals to ensure the safety of plant personnel during radiological emergencies.
AM	**Good Practice:** Strategies for the stabilization of the reactor core following a severe accident resulting in a core melt have been designed and installed by the plant and there were procedures for their implementation. **Suggestion:** The plant should consider improving the scope and the assessment of personnel undertaking Severe Accident Management training, exercises and drills to ensure an adequate level of knowledge and proficiency in the application of the Severe Accident Management guidelines at the plant. **Suggestion:** The plant should consider updating the plant accident management programme documentation to ensure revisions to the SAMGs basis information are evaluated and implemented and the revised guides are validated in a timely manner to ensure that the guidance available is optimized for the mitigation of a severe accident at the plant.

DEFINITIONS

Recommendation

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

Suggestion

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

Good practice

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

Good performance

A good performance is a superior objective that has been achieved or a good technique or programme that contributes directly or indirectly to operational safety and sustained good performance, that works well at the nuclear installation. However, it might not be necessary to recommend its adoption by other nuclear installations, because of financial considerations, differences in design or other reasons.

Self-identified issue

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

Encouragement

If an item does not have sufficient safety significance to meet the criteria of a ‘recommendation’ or ‘suggestion’, but the expert or the team feels that mentioning it is still desirable, the given topic may be described in the text of the report using the phrase ‘encouragement’ (e.g. the team encouraged the host organization to…).

REFERENCES

Safety Fundamentals (SF)

SF-1	Fundamental Safety Principles (Safety Fundamentals)

General Safety Requirements (GSR)

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

Specific Safety Requirements (SSR)

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

General Safety Guides (GSG)

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

Safety Guides (SG)

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

Specific Safety Guides (SSG)

SSG-2 Rev.1	Deterministic Safety Analysis for Nuclear Power Plants
SSG-3	Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants
SSG-4	Development and Application of Level 2 Probabilistic Safety Assessment for Nuclear Power Plants
SSG-13	Chemistry Programme for Water Cooled Nuclear Power Plants
SSG-25	Periodic Safety Review for Nuclear Power Plants

SSG-28	Commissioning for Nuclear Power Plants
SSG-38	Construction for Nuclear Installations
SSG-39	Design of Instrumentation and Control Systems for Nuclear Power Plants
SSG-40	Predisposal Management of Radioactive Waste from Nuclear Power Plants and Research Reactors
SSG-47	Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities
SSG-48	Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants
SSG-50	Operating Experience Feedback for Nuclear Installations
SSG-54	Accident Management Programmes for Nuclear Power Plants
SSG-61	Format and Content of the Safety Analysis report for Nuclear Power Plants
SSG-70	Operational Limits and Conditions and Operating Procedures for Nuclear Plants
SSG-71	Modifications to Nuclear Power Plants
SSG-72	The Operating Organization for Nuclear Power Plants
SSG-73	Core Management and Fuel Handling for Nuclear Power Plants
SSG-74	Maintenance, Testing, Surveillance and Inspection in Nuclear Power Plants
SSG-75	Recruitment, Qualification and Training of Personnel for Nuclear Power Plants
SSG-76	Conduct of Operations at Nuclear Power Plants
SSG-77	Protection against Internal and External Hazards in the Operation of Nuclear Power Plants

International Labour Office publications on industrial safety

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

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

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

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Observer 1