NSNI/OSART/206/2019

ORIGINAL: English

International Atomic Energy Agency

REPORT
of the

PRE-OPERATIONAL SAFETY REVIEW TEAM (PRE-OSART) MISSION

TO

FLAMANVILLE UNIT 3

NUCLEAR POWER PLANT

17 JUNE TO 4 JULY 2019

DIVISION OF NUCLEAR INSTALLATION SAFETY

OPERATIONAL SAFETY REVIEW MISSION

NSNI/OSART/206/2019

PREAMBLE

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

FOREWORD

Director General

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

An OSART mission, carried out only at the request of the relevant Member State, is directed towards a review of items essential to operational safety. The mission can be tailored to the particular needs of a plant. A full scope review would cover ten operational areas: management, organization and administration; training and qualification; operations; maintenance; technical support; operating experience feedback; radiation protection; chemistry; emergency planning and preparedness 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 Pre-OSART mission conducted at Flamanville Unit 3 Nuclear Power Plant in France from 17 June to 4 July 2019.

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

This Pre-OSART mission reviewed eleven areas: Leadership and Management for Safety; Training and Qualification; Operations; Maintenance; Technical Support; Operating Experience Feedback; Radiation Protection; Chemistry; Emergency Preparedness and Response; Accident Management; Human, Technology and Organization Interactions and Commissioning.

The mission was coordinated by an IAEA Team Leader and Deputy Team Leader and the team was composed of experts from Canada, Finland, Germany, Russia, Spain, Sweden, USA, and the IAEA staff members and observers from Russian Federation and Republic of Korea. The collective nuclear power experience of the team was 350 years.

The team identified 21 issues, resulting in 6 recommendations, and 15 suggestions. 8 good practices were also identified.

Several areas of good performance were noted:

- Liaison officer dedicated to Operating experience in sister plant Taishan for in-depth Operating experience sharing;
- Use of ‘post-Fukushima Box’ for fuel handling in adverse conditions;
- Effective implementation of a holistic Human Factors approach throughout the life cycle of the plant.

The most significant issues identified were:

- The plant should fully implement its Foreign Material Exclusion programme throughout all departments and areas to attain a high standard level of implementation;
- The plant should consider implementing procedures and practices to ensure that the potential impact of unsecured items on safety related equipment in seismically qualified areas is minimised;
- The plant should improve the arrangements and practices targeting the integrity of fire barriers and prompt fire suppression to ensure that fire risk is always minimized.

Flamanville 3 NPP management expressed their commitment to address the issues identified and invited a follow up visit in about eighteen months to review the progress.

CONTENT

INTRODUCTION AND MAIN CONCLUSIONS

INTRODUCTION

At the request of the government of France, an IAEA Pre-operational Safety Review Team (Pre-OSART) of international experts visited Flamanville Unit 3 Nuclear Power Plant from 17 June to 4 July 2019. The purpose of the mission was to review operating practices in the areas of Leadership and management for safety; Training and qualification; Operations; Maintenance; Technical support; Operating experience feedback; Radiation protection, Chemistry; Emergency preparedness and response; Accident management; Human, technology and organization interactions and Commissioning. In addition, an exchange of technical experience and knowledge took place between the experts and their plant counterparts on how the common goal of excellence in operational safety could be further pursued.

The Flamanville 3 NPP OSART mission was the 206th in the programme, which began in 1982. The team was composed of experts from Canada; Finland; Germany; Russia; Spain; Sweden; United States of America; the IAEA staff members and observers from Russian Federation and Republic of Korea. The collective nuclear power experience of the team was approximately 350 years.

Before visiting the plant, the team studied information provided by the IAEA and Flamanville Unit 3 NPP to familiarize themselves with the plant's main features and current performance, staff organization and responsibilities, and important programmes and procedures. During the mission, the team reviewed many of the plant's programmes and procedures in depth, examined indicators of the plant's performance, observed work in progress and held in-depth discussions with plant personnel.

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

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

MAIN CONCLUSIONS

The OSART team concluded that the managers of Flamanville Unit 3 NPP are committed to improving the operational safety and reliability of their plant. The team found good areas of performance, including the following:

- Liaison officer dedicated to Operating experience in sister plant Taishan for in-depth Operating experience sharing;
- Use of ‘post-Fukushima Box’ for fuel handling in adverse conditions;

- Effective implementation of a holistic Human Factors approach throughout the life cycle of the plant.

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

- The plant should fully implement its Foreign Material Exclusion programme throughout all departments and areas to attain a high standard level of implementation.
- The plant should consider implementing procedures and practices to ensure that the potential impact of unsecured items on safety related equipment in seismically qualified areas is minimised.
- The plant should improve the arrangements and practices targeting the integrity of fire barriers and prompt fire suppression to ensure that fire risk is always minimized.

Flamanville Unit 3 NPP management expressed a determination to address the areas identified for improvement and indicated a willingness to accept a follow up visit in about eighteen months.

1. LEADERSHIP AND MANAGEMENT FOR SAFETY

1.1. LEADERSHIP FOR SAFETY

The plant management team has strong alignment and works together effectively. Initiatives were undertaken to increase management coaching skills and competencies for performing effective field observations. These efforts were recognized as an area of good performance.

The DPN (Operating) organization has created a project for Safety Leadership that is designed to gradually increase the responsibility of the operating organization during the commissioning process. The team noted that in areas that have been handed over to DPN, standards and material condition is improved. The team encouraged DPN to consider how they can extend this effort to other areas under construction.

A review of events, near-misses, and field observations of workplace conditions identified that standards are not consistently met in some areas that could affect plant and personnel safety. These include industrial safety; fire protection; Exclusion of Foreign Material; and scaffolding. Additional effort is required to establish accountability and commitment by the workforce to meet established standards. The team made a recommendation in this area.

Nuclear safety is reinforced by senior management through multiple communication methods such as the daily operational focus meeting; weekly safety messages; monthly safety reports; a set of safety questions provided to all workers each month which is used for self-reflection; and an annual safety day for which no work is planned and activities are conducted which focus the plant staff on safety. The team recognized this as a good performance.

1.4. DOCUMENT AND RECORDS MANAGEMENT

A comprehensive document management system called ‘DOCUMENTUM’ is used at the plant. While provisions for the periodic review of procedures maintained in the system is established, detailed guidance on how to conduct periodic reviews has not been created to ensure that the reviews are comprehensive. The team encouraged the plant to consider developing criteria that would be used for those procedures which require periodic review to ensure the technical accuracy and usability of the procedure; that writing standards are met, and that internal and external operating experience is reflected in the procedure.

DETAILED LEADERSHIP AND MANAGEMENT FOR SAFETY FINDINGS

1.1 LEADERSHIP FOR SAFETY

1.1(1) Issue: Management expectations have not been effectively reinforced to ensure staff members consistently adhere to established standards in some areas important to plant and personnel safety.

The team noted the following:

Industrial Safety

- Performance during the construction phase has been cyclic. The Industrial Safety Accident Rate (ISAR) indicator for the plant did not meet the targets for 2018. The 2018 Industrial Safety Accident Rate (ISAR) target for DPN (Operating Organization) was 1.6, the actual was 5.7. The 2018 ISAR target for the entire plant (operating plus construction organizations) was 3.0, the actual was 6.4.
- Shortcomings in safety have contributed to several Events and Near Misses over the last two years:
  - Exposure and ingestion of oil;
  - Sealing of cable penetrations for incoming feeders of batteries on 3LAV and 3LAB switchboards performed in energized conditions;
  - Installation of scaffolding in 3SEF3250DG with trash rake energized in AUTO ready to start;
  - Energization of a non-transferred electrical penetration in the containment leak off monitoring system (3EPP-6149TWO);
  - Energization of a motor in the chilled water system (DER) during an insulation measurement.
- Two fatalities occurred during construction in 2011 and improvements in safety were realized over the following 4 years. However, it was noted that the accident rate in the AFA (Construction) Organization has trended up over the last three years. An initiative has been undertaken to align the DPN and AFA organizations on common approaches to industrial safety which are beneficial. However, challenges remain with effective coaching and oversight of contractor work in the field.
- Observations during the OSART identified several examples of workers not complying with established standards and expectations for industrial safety including inadequate safety precautions in the field and workers not correcting workplace hazards until identified by management.
- In 2018, DPN experienced 17 near-miss events with a goal of 12.

Foreign Material Exclusion

- FME standards at the plant are not consistently met. Observations during the OSART identified several examples of non-adherence to FME requirements:

  - Non-compliant plastic cable ties were used on cables around and above the spent fuel pool FME risk area and used on fuel handling bridge crane.
  - Access to the polar crane (which can travel above the reactor pool) is not secured and not posted as an FME Controlled area.
  - Scaffolding installed above FME controlled areas was not identified as an FME area even though items could fall from the elevated scaffold area into the FME controlled area.
  - Piping staged for installation in the plant did not consistently have FME covers installed. For example, 50 small bore pipes and tubes stored in the turbine operating floor storage area - FME covers are installed on some but not others.
  - Contrary to plant requirements, barriers for FME controlled areas are sometimes installed using general work area chains (red and white) or hazard chains ((black and yellow) rather than the required FME area chains (pink).

Fire Protection Programme

- Compliance with Fire Protection Programme requirements are not consistently met. During field observations the following examples were noted:
  - A fire door accessing the turbine building was blocked open, two fire doors in the staircase to the turbine operating floor were found left open.
  - A fire door next to Unit 3 I&C maintenance room was wedged open with a ventilation duct with no sign that the opening had been reviewed and approved. The plant expectation is to have an approval notice posted when fire doors have to be left open.
  - Some staff traveling through fire doors do not routinely verify that the door is firmly closed after passing through it.
  - Combustible loads were found stored in several areas without available fire protection (extinguishers, sprinklers, etc.).

Scaffolding

- Standards for the installation and use of scaffolding are not being consistently met, for example:
  - An operator was observed climbing scaffolding marked as not ready for use while hanging tags to support scheduled work activities.
  - In several cases, temporary scaffolds are in direct contact with plant equipment including safety related equipment.
  - Portable scaffolding was stored next to a SEC pipe (a safety related system) with its wheels unlocked.

Contributing to the challenges in compliance with standards and expectations are the large number of contractor workers (3000-4000 at different phases) with varying degrees of experience; differences in culture between AFA and DPN organizations; differences in how standards were implemented between DPN and AFA organizations; the large number of EDF employees that are new to nuclear (36%); shortcomings in effective oversight of workers by team leaders and supervisors; and limited peer-to-peer enforcement of standards by workers in the field.

If the plant staff does not strictly adhere to standards and expectations for key programmes such as industrial safety, FME control, Fire Protection, and scaffold control there is an increased risk to both plant and personnel safety.

Recommendation: The plant should reinforce management expectations and implement actions to ensure adherence to standards in those areas important to plant and personnel safety.

IAEA Bases:

SSR-2/2 (Rev.1)

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

GSR Part 2

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

(a) Setting goals for safety that are consistent with the organization's policy for safety, actively seeking information on safety performance within their area of responsibility and demonstrating commitment to improving safety performance;

(b) Development of individual and institutional values and expectations for safety throughout the organization by means of their decisions, statements and actions;

4.36. The organization shall make arrangements for ensuring that suppliers of items, products and services important to safety adhere to safety requirements and meet the organization's expectations of safe conduct in their delivery.

NS-G-2.4

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

6.61. A suitable working environment should be provided and maintained so that work can be carried out safely and satisfactorily, without imposing unnecessary physical and psychological stress on personnel. Human factors which influence the working environment and the effectiveness and fitness of personnel for duty should be identified and addressed. The operating organization should establish an appropriate programme for these purposes.

Examples of areas or activities to be reflected in this programme should include, but are not limited to, the following:

– adequacy of the resources, support and supervision provided to manage and perform the work;
– adequacy of lighting, access and operator aids;
– adequacy of alarms, considering factors such as their number, position, grouping, colour coding and prioritizing for audibility;
– frequency and clarity of communications;
– availability of suitable tools and equipment;
– duration of work time for personnel;
– the attention needed to be given to other factors, in particular for control room staff, including well-being, psychological and attitudinal problems, shift patterns and meal breaks; and
– the availability of procedures that take into account human factor considerations.

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, walkdowns of the facility and periodic observations of tasks with particular safety significance.

2. TRAINING AND QUALIFICATION

2.2. QUALIFICATION AND TRAINING OF PERSONNEL

Some elements of the Systematic Approach to Training (SAT) are not sufficiently implemented to ensure that all safety-related aspects are considered in training. SAT implementation was not yet complete; some important procedures for managing SAT phases were not in place. There were cases of improper identification of training needs; for example, no training on temporary modifications was provided. For many job positions, changes in competences were not tracked to ensure that no safety-related knowledge, skills and attitudes were missed. The team made a suggestion in this area.

Several aspects of the plant training process are not sufficiently robust to ensure the quality of the training programme. Across all key performance indicators (KPIs), there was no effectiveness indicator on how training affects plant performance, such as the number of events due a lack of training. Some of the key performance indicators do not provide motivation to improve the effectiveness of training. In many cases, there were no analyses made on overdue or missed attendance targets. The plant self-assessment in training did not include corrective actions as well as target dates to perform those actions. The team made a suggestion in this area.

The plant has implemented a control system mock-up simulator facility replicating the standard I&C, turbine and generator control systems for training purposes. This facility is used for training of I&C and electrical maintenance staff. In addition, the facility enables development and testing of control system changes before implementing those changes on the plant. The use of the facility has increased the quality of maintenance of equipment at the commissioning stage. The team recognized this as a good performance.

FLA3 operators have developed a ‘Post Fukushima box’ filled with tools enabling them to place a fuel element in a safe position in case of plant blackout in the fuel building. They include portable lights with batteries charged, autonomy phone, portable tools, breathing air sets with air bottles filled. The use of these tools in adverse conditions is described in a procedure provided in the box. The box will be located nearby the pool, close to the spent fuel machine. All necessary equipment to operate fuel during blackout is maintained in good operational condition available and ready for use and monitored under the surveillance programme. The team recognized this as a good practice.

DETAILED TRAINING AND QUALIFICATION FINDINGS

2.2. QUALIFICATION AND TRAINING OF PERSONNEL

2.2(a) Good practice: Use of post-Fukushima Box for fuel handling in adverse conditions

FLA3 operators have developed a 'Post Fukushima box' (fig.1) filled with tools enabling them to place a fuel element in a safe position in case of plant blackout in the fuel building.

They include portable lights with batteries charged, autonomy phone, portable tools, breathing air sets with air bottles filled. The use of these tools in adverse conditions is described in a procedure provided in the box. with the main following steps:

- Deploy equipment of the 'post Fukushima box' in the dark;
- Use the spent fuel machine manually with specific marks (X,Y et Z) around the pools or cavities;
- Secure the fuel in safe position manually.

The box will be located nearby the pool, close to the spent fuel machine. All necessary equipment to operate fuel during blackout is maintained in good operational condition available and ready for use and monitored under the surveillance programme. A comprehensive approach has been developed to use the box and relevant training has been given to the relevant staff.

Benefits:

Enhanced readiness of teams in charge of fuel operations to deal with adverse situations.

Results:

The box enables staff to find and use easily all equipment needed to place fuel in a safe position in case of a blackout.

Fig.1 Post-Fukushima blackout box

2.2(1) Issue: Some elements of the plant's Systematic Approach to Training (SAT) are not sufficiently implemented to ensure that all safety-related aspects are considered in training.

The team noted the following:

In terms of SAT methodology:

- The plant follows Corporate procedures on SAT; however, those procedures were not sufficiently detailed at the plant level to define staff responsibilities.
- The plant procedure did not require the plant departments' agreement on the safety-related technical content of training materials.

In terms of needs and job analysis:

- Some important procedures for managing SAT phases, such as changing the relevant safety-related training objectives when a relevant job was changed, were not in place.
- The plant has only analysed 35 out of 79 job positions according to the SAT methodology. In 2019, 10 more job positions are expected to be analysed, and the other 34 job positions will be analysed after 2019. Non-SAT-based training programmes were still being used for training.
- The Steam Generator Tube Rupture (SGTR) simulator exercise guide (pedagogical dossier) for MCR staff initial training did not include references to the competences to be taught during the session to ensure that all safety-related knowledge and skills were addressed.
- 'Managing different types of plant waste' classroom training (ref. UFPI/OP2/ERQ/15-00457 and UFPI/OP3/ERQ/15-00458) included specific knowledge to be taught. However, there were no links to the job competences and there was no evidence that all safety-related knowledge and skills belonging to the job position were in line with SAT analysis results.
- Not all permanent safety-related modifications were the subject of training. Approximately 6,000 modifications have been implemented since 2019, including some on safety system equipment. However, the plant believed that 95% of those did not require changes to training materials, since the training objectives were at a generic level, therefore for most of modifications training was not developed. In addition, there was no procedure on how to integrate, develop and conduct training on modifications.

In terms of design and development of training programmes:

- There were no plant expectations on how to develop and conduct focused and just-in-time (JIT) training for safety-related tasks.
- The plant develops JIT training sessions in response to department manager requests. To meet needs, the plant has adapted the available programmes for job positions. However, when the training programmes were adapted, a portion of the training was developed on the basis of developer judgement, and SAT was not used in terms of the competences needed for the job. No procedure was available regarding the criteria for waiving portions of the safety-related training.
- The JIT training guide for safety engineers was developed by the department staff. The purpose of this training guide was to refresh the knowledge and skills of safety engineers on the Full-Scope Simulator to control the plant status. Training personnel did not

participate to provide overall ownership of these training materials. This guide was not included in the database as an official training guide.

- There was no procedure on how to incorporate document changes and plant modifications on systems important to safety into training.
- Records were not in place for examination test development for Reactor Operator and Unit Shift Supervisor, confirming that test items were linked to required competences.
- The VISION software to support SAT-compliant development of the training did not track changes needed in training materials in the event of new or revised safety-related knowledge or skills.
- JIT training on how to operate low voltage and high voltage equipment (Recyclage HE/BE Manoeur BS-HoV, as of December 2016) was not developed according to the SAT. It included PowerPoint slides only, with no lesson plan. Most of the training objectives defined for the classroom session were skills based and could not be achieved in the classroom. The content of the classroom session had 136 slides with only one training objective. No summary was provided to emphasize safety aspects of the work.

Without comprehensive implementation of the Systematic Approach to Training, there is a risk that not all safety-related aspects will be properly considered in training.

Suggestion: The plant should consider improving the implementation of the Systematic Approach to Training to ensure that all safety-related aspects are considered in training.

IAEA Bases:

SSR-2/2 (Rev.1)

4.16. The operating organization shall clearly define the requirements for qualification and competence to ensure that personnel performing safety related functions are capable of safely performing their duties.

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

NS-G-2.8

4.13 A systematic approach to training should be used for the training of plant personnel. The systematic approach provides a logical progression, from identification of the competences required for performing a job, to the development and implementation of training towards achieving these competences, and to the subsequent evaluation of this training. The use of a systematic approach to training offers significant advantages over more conventional, curricula driven training in terms of consistency, efficiency and management control, leading to greater reliability of training results and enhanced safety and efficiency of the plant.

2.2(2) Issue: Several aspects of the plant training process are not sufficiently robust to ensure the quality of the training programme.

The team noted the following:

In terms of training performance evaluation:

- The KPIs and trends used for evaluating Training Centre performance focus on numbers, rather than training effectiveness. The plant followed General Safety Policy (memo D4008/10.11.18/05.21, Period 2020-2022). Annually the plant receives the Corporate target in training man-hours to be performed. The target for 2018 was about 56,000 man-hours; the target for 2019 is about 54,000 man-hours. According to plant indicator SP7.1-05, the target for a given year cannot be changed by more than 2% from the target for the previous year. This does not provide motivation to improve the effectiveness of training, which could result in a large change in the target.
- There were 21 KPIs assigned to the TC by plant management, 17 KPIs assigned to the TC by Corporate, and 4 KPIs arising from the Integrated Management System. No integrated impact evaluation report was done. There was no training effectiveness performance indicator across all 42 KPIs, such as a number of events due a lack of training. Even though the plant is not yet in power operation there were numerous events related to human factors; however, since these events are not tracked by the TC, training effectiveness could not be evaluated.
- The plant conducted a self-assessment (SA) in training. However, no corrective actions were developed in the 2018 SA report, and no target dates to perform corrective actions were put in place. In addition, it was not clear how the SA results and the TC plans avoided contradiction with the actions of other departments, and what were the provisions to support a corrective plan in terms of resources.

In terms of training tools:

- Procedures for configuration control of training tools (such as the Full-Scope Simulators FLA-A, FLA-B, FLA-C) to control and validate that all elements of the training setting met the training requirements were not in place. This included, in particular, the Full Scope Simulator, corresponding training materials, instructor readiness, and plant procedures for MCR crew training, as well as the mock-up facility for maintenance training) No reports were prepared on validation of training tools, and whether they were approved for training.
- Each of the three FSS did not include 20 systems that will be operated from the MCR.
- The plant planned to use the Local Control Center (LCC) for local operation of support systems by field operators. However, the LCC is not commissioned yet and at the time of the OSART mission the LCC simulator had not been commissioned for training purposes. A significant number of those systems, such as DWN (Nuclear Auxiliary Building Ventilation System), TEG (Gaseous Waste Processing System), TEP (Coolant Storage and Treatment System) and others, were required to be operable from the LCC before fuel loading;
- The maintenance workshop, located in building HB0, was used for maintenance training. It included mock-ups of plant mechanical and electrical equipment. However, this temporarily located facility had deviations in the training setting:

  - 3 mechanical mock-ups did not have FME caps;
  - no training materials were used during the training session, only plant procedures;
  - a metal ladder was installed 20 cm from an electrical cabinet, with the risk of it falling on the cabinet;
  - housekeeping issues posed risks of injury to trainees.

In terms of conduct of training:

- The training videos on industrial safety for FLA 3 observed by the team contained numerous deviations from the FLA 3 plant expectations, such as:
  - not using helmet chin straps;
  - persons in work areas without helmets;
  - persons standing under a heavy load during lifting;
  - graffiti on equipment was not removed;
  - when called on the telephone, the person did not write down the information received;
  - in many cases, work overalls were damaged or not buttoned;
  - in many cases, transportation zones were not established;
  - staff did not use pedestrian crossings;
  - some scaffolding did not have flanges;
  - lifting in the fire risk zone;
  - in some cases, work areas did not have barriers.

The Training Centre did not review the training content before using it in training for plant personnel.

- During the observation of classroom training on Liquid Waste Treatment, the instructor did not conclude the lesson by emphasizing safety-related issues. Training materials, namely the specification (cahier de charges) and training file (dossier pedagogique) were not followed.

Without a robust training process, quality of the training programme could be compromised.

Suggestion: The plant should consider improving the training process to ensure the quality of the training programme.

IAEA Basis:

NS-G-2.8

4.1. The operating organization is responsible for training its own staff and ensuring that contractors' staff are suitably trained and experienced so that all work is carried out safely.

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

4.8. It should be the responsibility of the plant manager, with reference to each position important to safety, to ensure that:

– training needs are continuously analysed and an overall training programme is developed;
– the training unit is provided with all necessary resources and facilities;
– the performance of all trainees is assessed at various stages of the training;
– the effectiveness of the training is evaluated;

4.15. The following training settings and methods, which are widely used and have proved to be effective in attaining the training objectives when appropriately chosen, should be considered:

(a) The classroom is the most frequently adopted training setting. Classroom training time should be carefully controlled and structured to achieve the training objectives in a timely and efficient manner. Its effectiveness should be enhanced by the use of appropriate training methods such as lectures, discussions, role playing, critiquing and briefing. Training aids and materials such as written materials, transparencies, audio and video based materials, computer based systems, plant scale models and part-task simulators should be used to support classroom instruction where necessary.

(b) On the job training should be conducted in accordance with prescribed guidelines provided by incumbent staff who have been trained to deliver this form of training. Progress should be monitored and assessments should be carried out by an independent assessor.

(c) Initial and continuing simulator based training for the control room shift team should be conducted on a simulator that represents the control room. The simulator should be equipped with software of sufficient scope to cover normal operation, anticipated operational occurrences and a range of accident conditions. Other personnel may also benefit from simulator based training.

(d) Training mock-ups and models should be provided for activities that have to be carried out quickly and skilfully and which cannot be practised with actual equipment. Training mock-ups should be full scale if practicable. Laboratory and workshop training should be provided to ensure safe working practices in those environments.

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

4.24. In initial and continuing training, trainees should be evaluated by means of written, oral and practical examinations or by discussions of the key knowledge, skills and tasks required for performing their jobs.

4.25. An initial training programme should be established for all plant personnel to achieve the necessary competence to carry out their jobs. Initial training should help personnel to achieve a high level of performance in terms of safety and professionalism, in order to meet the operational standards required to ensure safe operation of the plant.

5.31. Training instructors, on and off the site, should have the appropriate knowledge, skills and attitudes in their assigned areas of responsibility. They should thoroughly understand all aspects of the contents of the training programmes and the relationship between these contents and overall plant operation. This means that they should be technically competent and show credibility with the trainees and other plant personnel. In addition, the instructors should be familiar with the basics of adult learning and a systematic approach to training, and should have adequate instructional and assessment skills.

3. OPERATIONS

3.1. ORGANIZATION AND FUNCTIONS

The plant has developed and made a simulator available at the staffs' disposal, conveniently located close to the Main Control Room (MCR). As the simulator is on the same level as the MCR, in the administrative part of the building, the operators only have to walk a short distance for access. During periods of steady operation, when the full staff complement is not required in the MCR, some of the operators can take the opportunity to practice in this simulator. The simulator replicates the human-machine interface of the real control room and the software is a copy of that installed on the full scope simulator. The team recognized this as a good performance.

3.4. CONDUCT OF OPERATIONS

The plant has defined clear responsibilities for the operations and commissioning teams to control the status of equipment and areas which are at different levels of readiness for operations. However, the team observed that in some areas, conditions do not fully guarantee that safety of equipment in testing or operation is not placed at risk. Some deviations in material condition or prevention of unauthorized access to a safety related equipment rooms were not identified or reported during field operator's rounds. Some arrangements for clear identification and protection of safety related equipment have not been developed and implemented. The team made a suggestion in this area.

The plant has implemented a project to improve tagging and line-up using mobile devices. The mobility part involves giving all field operators and tagging officers' mobile phones with dedicated applications in order to improve the efficiency of field activities. These applications include Easy Work Request, a tool that can be used to search, create and monitor work requests very easily in real time while in the field. The interface is designed to be simple and intuitive. The user can add images, videos or sound recordings to support the work request. The application reinforces the ownership of work requests by field operators. The team identified this as a good performance.

DETAILED OPERATIONS FINDINGS

3.4. CONDUCT OF OPERATIONS

3.4(1) Issue: The plant has not taken necessary actions to maintain the material condition and protection of safety related equipment to ensure equipment availability.

The team noted the following:

– The plant does not have requirements for the clear identification of the status of components in the field on whether they are in construction, commissioning or operation mode.

– The plant has not yet implemented the procedure for identification and physical protection of redundant safety trains unaffected by maintenance or testing.

– The plant has no requirement to keep rooms housing 0.4 kV and 10 kV switchboards for equipment important to safety locked if there are no accessible parts that are energized.

In construction and commissioning teams' responsibility areas:

– There is no requirement to have defect tags in place for the equipment which is in the commissioning phase.

– Safety injection pump 3RIS4420PO (which is in the testing phase) was not labelled. Related equipment for the pump was labelled with temporary handwritten labels.

– A cable was laying on the safety injection pump 3RIS4420PO shaft.

– Cables in reactor building room HK1088 were compressed by erected scaffolding which could cause damage.

– Cables were laying across the rails for the fuel machine in the spent fuel pool room in the reactor building.

In operations department's responsibility areas:

– The plant has not implemented a procedure for managing operator aids.

– Two pumps inside the pumping station were found with oil seeping from the bearings. There were no defect tags in place in either case.

– A small oil leak from the supporting auxiliary feed water pump 3ASG7210POM bearing (safety-related, in commissioning) and minor deviations such as untied cables, open fire door, fire damper cover laid on the cable tray, were not identified by the operator during the plant tour in the pumping station.

– Some breakers of the switchboard transferred to operations were not properly secured with padlocks and padlocks controlled by the commissioning team.

– There was a water puddle about 5cm by 5cm under the Plant Blackout Diesel Generator 3LJP (not identified by a work request).

Without full implementation of necessary actions to maintain the material condition and protection of safety related equipment its availability cannot be ensured.

Suggestion: The plant should consider full implementation of necessary actions to maintain the material condition and protection of safety related equipment to ensure equipment availability.

IAEA Bases:

SSR-2/2 (Rev.1)

Requirement 23: Non-radiation-related safety

The operating organization shall establish and implement a programme to ensure that safety related risks associated with non-radiation-related hazards to personnel involved in activities at the plant are kept as low as reasonably achievable.

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.

7.6. A clear operating policy shall be maintained to minimize the use of, and reliance on, temporary operator aids. Where appropriate, temporary operator aids shall be made into permanent plant features or shall be incorporated into plant procedures.

Requirement 28: Material conditions and housekeeping

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

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

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

NS-G-2.14

4.35. Personnel assigned the task of carrying out rounds should be made responsible for verifying that operating equipment and standby equipment operate within normal parameters. They should take note of equipment that is deteriorating and of factors affecting environmental conditions, such as water and oil leaks, burned out light bulbs and changes in building temperature or the cleanness of the air. Any problems noted with equipment should be promptly communicated to the control room personnel and corrective action should be initiated.

5.1. A consistent labelling system for the plant should be established, implemented and continuously maintained throughout the lifetime of the plant. It should be ensured that the system is well known by the staff. The system should permit the unambiguous identification of every individual component in the plant.

5.6. Specific measures should be developed and maintained to prevent unauthorized access to systems and equipment important to safety. These measures should include controlled access to certain rooms or compartments and an effective key control system or other measures to prevent an unauthorized change in the position of, or an unauthorized intervention affecting, certain important safety valves, transmitters, breakers or other specified equipment.

6.23. All plant equipment should be made easily accessible to field operators.

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

SSG-28

3.44. The following interfaces between commissioning activities and operating activities in particular should be considered:

- Provisions in the specification of the role, functions and delineation of responsibilities of the operating group and the commissioning group before the transfer of structures, systems and components for operation;
- Changes in responsibility for safety, depending on the milestones in commissioning that are considered and the transfers to operation that are performed, including the nomination of responsible persons;
- Conditions for access of personnel, with account taken of the delineation between systems already in operation and systems being tested;
- Control of temporary procedures and equipment that are available during commissioning but not appropriate to normal operation, for example, special startup instrumentation or duplicate safety keys and authorization for the use of jump and lifted leads;
- The implementation of operating requirements and maintenance requirements for structures, systems and components as each system is transferred to the operating group;

3.46. Procedures for operating and periodic testing should be used in the commissioning stage as far as the conditions at the plant will allow, so as eventually to validate the procedures with success criteria more numerous or more challenging than those to be used during operation. Interorganizational arrangements should be made to schedule this activity so as to ensure that procedures, including operating, maintenance and surveillance procedures, are adequately validated.

3.47. Personnel should adhere to normal operating rules such as those relating to access to the control room, access to control cabinets and switchboards, control of information, communication with the control room about abnormalities and changes to plant configuration.

SSG-38

4.16. The principal activities of the personnel in the construction organization should include the following, as a minimum:

(b) Ensuring that the construction organization and contractors are established on the site in a controlled manner in allocated areas and are provided, where appropriate, with the necessary site services, information and instructions with regard to the applicable nuclear safety and industrial safety requirements;

(d) The preparation of safety related working procedures, including industrial, environmental and safety procedures, for issue to the personnel of the construction organization and contractors, and the verification that the industrial safety arrangements of the construction organization and contractors on the construction site comply with the applicable requirements;

(e) The monitoring of nuclear safety and industrial safety policies and of the activities of all personnel, to ensure compliance with statutory and regulatory requirements with regard to quality and safety;

(h) Ensuring preservation of installed equipment, by carrying out maintenance of the equipment as required, ensuring proper care of equipment that could deteriorate during construction, such as equipment for dehumidification of electrical equipment and preservation of critical surfaces that could rust, and the performance of adequate housekeeping activities to protect open equipment against intrusion of foreign materials and contaminants;

4. MAINTENANCE

4.5. CONDUCT OF MAINTENANCE

To perform load tests on monorail crane equipment the installation of test loads equivalent to 1.5 times the safe working load (SWL) of the crane is necessary. This type of activity involves many heavy load handlings in buildings and near to, or above, safety related equipment. The test kit makes it possible to perform these load tests without using a load. The required test force is provided by two hydraulic cylinders. The hydraulic system is pressurized using a hand pump, without electrical or air energy source. This test kit is able to perform all load test for monorails up to 2 tons SWL. However, the same kit is also available for testing up to 15 tons SWL. The team considered this as a good performance.

A portable visual acoustic pressure meter with visual display is used in potentially noisy workspaces to measure the current sound-volume and display it visually as a pictogram. If the measured value exceeds 80 dB, the green illuminated display switches to a yellow display. The team considered this as a good performance.

Tie-off points for attaching a safety harness are permanently installed at all potential crash surfaces and floor openings, to secure a harness or fall arrester. They enable workers to perform their job safely when a risk of fall from height is present. When their yearly check is due, and/or the tie-off point is damaged, it is tagged out using a tagging device. The team considered this as a good practice.

4.6. MATERIAL CONDITION

There are notable differences regarding the material condition between buildings, systems and components that have been handed over to the plant organization and buildings, systems and components in commissioning or in the test phase. These differences are reflected particularly in precautions against foreign material exclusion. The plant has focused attention on this topic on the spent fuel pool and the reactor cavity, however, the team observed several cases of inappropriate implementation of FME policy. The Team made a recommendation in this area.

DETAILED MAINTENANCE FINDINGS

4.5. CONDUCT OF MAINTENANCE

4.5(a) Good Practice: Tie-off points for attaching a safety harness are permanently installed at all potential crash surfaces and floor openings, (see figure 1) to secure a harness or fall arrester. They enable workers to perform their job safely when a risk of fall from a height is present. Their maximum rated load capacity is (10kN). These tie-off points are checked once a year to ensure usability. When their yearly check is due, and/or the tie-off point is damaged, it is tagged out using a tagging device. See Figure 2.

Figure 1: Tie-Off Point

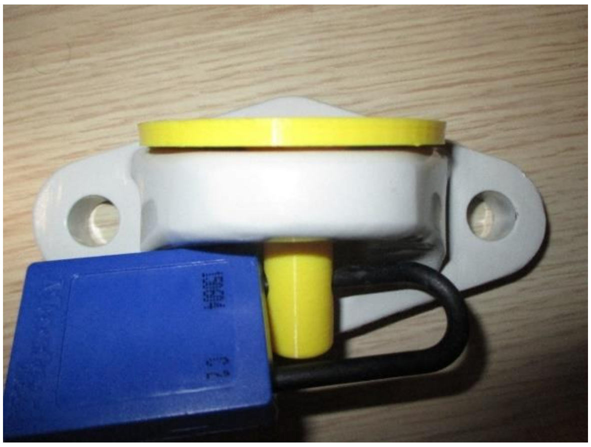


Figure 2: Tagged-out Tie-Off Point

Benefits:

Safe access to locations where there is a risk of fall from a height (floor openings, movable floor gratings, access to cranes and platforms).

Results:

Since the implementation of these tie-off points no event due to fall from a height have been recorded.

4.6. MATERIAL CONDITION

4.6(1) Issue: The Foreign Material Exclusion (FME) programmme is not fully implemented at the plant to ensure that foreign materials are prevented from entering the plant systems and components.

The team noted the following:

- Five breakers for Station Blackout Diesel Generator 3LJP were racked out in two different electrical control rooms. The openings were not covered to protect them from potential foreign material dropping inside.
- Four flexible water hoses, laying on a palette in the nuclear auxiliary building, were observed without FME covers on their ends. Foreign materials could be injected into safety systems.
- Several unused holes were not covered or capped in a reactor building electrical penetration. Foreign materials could migrate inside the penetration and cause electrical damage.
- FME covers in the maintenance workshop were used in different ways. One was used for collecting nuts and bolts, some others for plugging holes.
- FME covers which were not in use were lying around on workbenches and on pallets.
- An FME cover was not properly installed on the top of the concrete mixing equipment in the waste treatment building, because it is not adapted for use on this type of equipment.

Without rigorous implementation of an effective Foreign Material Exclusion program, when performing activities in the plant, the potential for foreign material intrusion could be significantly increased.

Recommendation: The plant should fully implement its FME programme throughout all departments and areas to ensure that foreign materials are prevented from entering the plant systems and components.

IAEA Bases:

SSR-2/2 (Rev.1).

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

NS-G-2.5;

3.9. The areas for the handling and storage of fresh fuel should be maintained under appropriate environmental conditions (in respect of humidity, temperature and clean air) and controlled at all times to exclude chemical contaminants and foreign materials.

3.19. Inspections should neither damage the fuel nor introduce any foreign material into it. Inspectors should identify any foreign material already present in the fuel and should remove it.

4.2. The steps necessary to assemble fresh fuel and to prepare it for use in the reactor should be specified in the procedures, including any arrangements for holding it in intermediate storage. Only approved fuel should be loaded into a reactor core. Checks should be carried out to confirm that the fuel has been assembled correctly. In all procedures for fuel handling and maintenance, it should be ensured as far as possible that no foreign material is introduced into the reactor.

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

6.8. Where appropriate, programmes should be established for the surveillance and maintenance of core components during service. Checks should be made for physical changes such as bowing, swelling, corrosion, wear and creep. These programmes should include examination of components to be returned to the core for further service and examination of discharged components in order to detect significant degradation during service. Maintenance programmes should include procedures to prevent the introduction of foreign materials into the reactor.

5. TECHNICAL SUPPORT

5.1. ORGANIZATION AND FUNCTIONS

The plant has no specific guidelines or rules for the storage of materials in seismically qualified areas in the commissioning phase. The plant does not assess risk for potential seismic interaction between stored items and safety related equipment. The team noted that the plant does not provide observations regarding seismic risk in the areas that have not been handed over. The team also noted seismic issues at several locations in these areas and also in buildings that have been handed over to the plant, where the plant has clear expectations. The team made a suggestion in this area.

5.4. AGEING MANAGEMENT

The plant has developed an extensive programme to monitor equipment reliability and to monitor the environmental conditions of all relevant components and locations. The plant has developed a surveillance programme for the reactor pressure vessel. Several databases have been developed to record different Ageing Management Programme (AMP) data, however there is no overall programme which integrates all relevant ageing data in a systematic way. The team encouraged the plant to develop the overall AMP.

5.6. SURVEILLANCE PROGRAMME

The team observed that changes to the plant’s surveillance programme are still under consideration and 404 out of 783 surveillance procedures have not been updated. The team noted that the process of updating surveillance procedures does not always ensure the correctness of procedures. The team made a suggestion in this area.

5.7 PLANT MODIFICATION SYSTEM

The plant has made efforts to minimize unauthorized access to, or interference with, I&C items important to safety, including computer hardware and software. The plant introduced effective methods based on appropriate combinations of administrative measures and physical access control (such as locked enclosures, locked rooms and alarms on enclosure doors) to prevent unauthorized access and to reduce the possibility of error. The team recognized this as a good performance.

5.8. REACTOR CORE MANAGEMENT (REACTOR ENGINEERING)

The reactivity management programme is not yet fully implemented in the plant. The plant is in the phase of validating and verifying the plant-specific reactivity management requirements in the field. Due to the extensive use of an offsite control system test platform for design and commissioning needs, some surveillance test and maintenance procedures related to I&C parameter modification could not be performed as planned. Commissioning staff are not fully aware of the importance of the reactivity management programme. The team encouraged the plant to finalize the implementation of all activities associated with reactivity management.

DETAILED TECHNICAL SUPPORT FINDINGS

5.1. ORGANIZATION AND FUNCTIONS

5.1(1) Issue: The plant procedures and practices do not always ensure that the potential risk from the impact of unsecured items on safety related equipment in seismically qualified areas is minimised.

During the review of the areas with construction and commissioning activities the team noted:

- The plant has no specific procedures and guides for storage of equipment in seismically qualified areas in the commissioning phase. The plant practice is to place a white chain fence around equipment. There is an instruction that trollies, scaffolds, and heavy equipment should have their brakes locked, this instruction also applies to commissioning.
- In the fuel pool area, multiple cases of heavy objects such as a trolley with tools; a trolley with protective tiles and a trolley that supports equipment were observed and found unsecured at locations that have not been designated as storage areas.
- In the auxiliary safety system building, a trolley was found near the safety related equipment not secured from inadvertently moving.
- In the auxiliary safety system building temporary storage with trolleys and ladders was found without appropriate signs.

The plant has expectations for the storage of equipment in buildings that have been handed over to operations. However, during the review the team noted:

- In the train 3 pumping station, temporary scaffolds (about 1m x 2m x 3m in size and with their four wheels unlocked) were in contact with an essential service water pipe, which is safety related system.
- An approximately 2m x 2m x 4m scaffold was in contact with a non-return valve of the fire protection duct in the train 3 pumping station containing essential service water components.
- In the train 1 pumping station, an open hatch had unsecured materials stored next to the opening.
- In the train 1 pumping station, a trolley with its four wheels unlocked was stored unsecured next to the electrical panels in the switchgear room.
- In the train 1 pumping station, a heavy key storage rack was found next to the electrical panels in the switchgear room and was not fixed.

Without proper procedures and practices in controlling of additional items in seismically qualified areas, the operability and reliability of structures, systems and components could be jeopardized.

Suggestion: The plant should consider implementing procedures and practices to ensure that the potential impact of unsecured items on safety related equipment in seismically qualified areas is minimised.

IAEA Bases:

GSR Part 2

4.32. Each process or activity that could have implications for safety shall be carried out under controlled conditions, by means of following readily understood, approved and current procedures, instructions and drawings.

SSR-2/2 (Rev.1)

Requirement 13. The operating organization shall ensure that a systematic assessment is carried out to provide reliable confirmation that safety related items are capable of the required performance for all operational states and for accident conditions.

NS-G-2.13

5.33. Plant walk-downs are one of the most significant components of the seismic safety evaluation of existing installations, for both the SMA and the SPSA methodologies. Plant walk-downs should be performed within the scope of the seismic safety evaluation programme. The term ‘plant walk-down’ is used here to denote the ‘seismic capability walk-down’ for the SMA approach and the ‘fragility walk-down’ for the SPSA approach. These walk-downs may serve many purposes, such as: gathering and verifying as-is data; verifying the screening-out of SSCs due to high capacities on the basis of engineering judgement; verifying the selection of safe shutdown paths for the SMA; evaluating in-plant vulnerabilities of SSCs, specifically issues of seismic system interaction (impact, falling, spray, flooding); identifying other in-plant hazards, such as those related to temporary equipment (scaffolding, ladders, equipment carts, etc.); and identifying the ‘easy fixes’ that are necessary to reduce some obvious vulnerabilities, including interaction effects. Walk-downs should also be used to consider outage configurations that are associated with shutdown modes. Detailed guidance on how to organize, conduct and document walk-downs should be developed or adapted from existing walk-down procedures.

5.6. SURVEILLANCE PROGRAMME

5.6(1) Issue: The process for the development and approval of surveillance procedures is not sufficiently rigorous to support safe plant operation.

The team observed the following:

- Surveillance test procedures are written and verified by the operations department or by a contractor and approved by the operations department. Safety engineers and system engineers are not involved in the verification of procedures.
- The independent evaluation of the surveillance process made in year 2016-2017 provided the suggestion to improve the process for updating procedures (the engineering department recognised that the process could be improved, while operations thought the process did not need to be improved to avoid mistakes). In 2018, the operations department introduced some changes in the guideline for updating surveillance procedures; however, the errors appeared again.
- Independent evaluation identified that two lines of defence applicable during the writing and approval of surveillance procedures failed (use of the wrong reference documents, improper understanding of acceptance criteria, non-rigorous independent verification and approval process).
- Errors were identified in procedures related to electrical containment penetrations and sensor codes. The operations department additionally reviewed surveillance procedures for the containment penetration and did not extend the analysis of the cause of these events to identify whether the same problem had occurred in other surveillance test procedures.
- Surveillance test procedures for systems related to reactor control are still under development, and only 3 procedures of the planned 120 documents have been written and approved.
- The plant identified that 149 procedures out of 783 surveillance test procedures are sensitive and complex. Forty-eight are required to be available for the phase 2 hot functional test milestone. However, not all of these are yet updated.

Without a rigorous process for the timely development and approval of surveillance procedures safe plant operation might be affected.

Suggestion: The plant should consider improvements to the rigour of the process for timely development and approval of surveillance procedures to ensure support for safe plant operation.

IAEA Bases:

SSR-2/2 (Rev.1)

8.2. The operating organization shall establish surveillance programmes for ensuring compliance with established operational limits and conditions and for detecting and correcting any abnormal condition before it can give rise to significant consequences for safety.

NS-G-2.6

2.12. The operating organization should establish a surveillance programme to verify that the SSCs important to safety are ready to operate at all times and are able to perform their safety functions as intended in the design. Such a surveillance programme will also help to detect trends in ageing so that a plan for mitigating the effects of ageing can be prepared and implemented.

9.1. A surveillance programme should be established by the operating organization to verify that provisions for safe operation that were made in the design and checked during construction and commissioning continue in effect during the operating lifetime of the plant and continue to supply data to be used for assessing the residual service life of SSCs. At the same time, the programme should verify that the safety margins are adequate and provide a high tolerance for anticipated operational occurrences, errors and malfunctions.

9.7. The surveillance programme should be developed by the operating organization sufficiently early to permit it to be properly implemented as and when plant items become operational in the commissioning phase or, where appropriate, upon installation. Implementation should be scheduled such that the safety of the plant does not depend on untested or unmonitored SSCs.

6. OPERATING EXPERIENCE FEEDBACK

6.7. UTILIZATION AND DISSEMINATION OF OPERATING EXPERIENCE

The plant's Corrective Action Programme (CAP) has not been effective in addressing performance deficiencies and adverse trends in a timely manner. The team observed deficiencies that have not been reported; performance targets that had consistently not been achieved; corrective actions that have not resulted in any visible improvement; self-assessments that have not been utilized to determine the effectiveness of programmes; and a lack of action plans to address a variety of performance deficiencies. The team made a recommendation in this area.

6.8. TRENDING AND REVIEW OF OPERATING EXPERIENCE

The plant has established an agreement with its sister plant Taishan to receive in-depth knowledge of Operating Experience (OE). One of the key elements in this agreement consists of a liaison engineer seconded to Taishan who communicates OE to both plants. The second key element is that Flamanville 3 take part in Taishan's operational activities and evolutions which provided them with valuable first-hand experience and knowledge. Conversely 16 employees from Taishan are taking part in FLA3's commissioning activities to share their technical expertise and mentor staff. The team considered this as a good practice.

The plant demonstrated well established processes and review meetings to ensure that external and internal OPEX is reviewed and analyzed for use by Flamanville 3 staff and that internal OPEX is communicated to the rest of industry. These processes were well understood by all staff interviewed and the participants in the review meetings demonstrated a bias for action. The team considered this as good performance.

DETAILED OPERATING EXPERIENCE FEEDBACK FINDINGS

6.7. UTILIZATION AND DISSEMINATION OF OPERATING EXPERIENCE

6.7(1) Issue: The plant Corrective Action Programme (CAP) is not effective in addressing performance deficiencies and adverse trends in a timely manner.

The team observed the following:

- Many different types of deficiencies and adverse performance trends were not reported in the plant's CAP.
- The plant's Department Trend Reports for the 1st Quarter of 2019 each identified adverse trends, however 5 of 6 of the trend reports did not identify any actions to fix the adverse trends.
- The plant has not utilized self-assessments to determine the effectiveness or implementation of the Operating Experience (OE) Programme.
  - No Plant wide self-assessment plan for OE or the CAP ;
  - 75% of Managers interviewed indicated they had not done a self-assessment on the implementation of the OE programme within their departments.
- The plant's actions (recorded in minutes of meetings) have not been effective in improving the percentage of overdue actions, which has not met target in over 6 months.
- The plant has not established a corrective action plan for the WANO SOER on Risk Management that was graded unsatisfactory in April 2018. A corporate team has been established to develop plan and meets monthly, however there is still no action plan 14 months later.
- The plant has not conducted trend analysis of housekeeping deficiencies to establish corrective actions to prevent re-occurrence.
- Plant Managers and staff interviewed did not have a good awareness of what the plant OE performance indicators are in order to help the plant improve performance.
  - 47% Awareness of Participation Rate Indicator;
  - 47% Awareness of Participation Rate Target;
  - 18% Awareness of Escalation of Priority to address Participation Rate Indicator;
  - 65% Awareness of % of Overdue Actions Indicator;
  - 41% Awareness of % of Overdue Actions Target;
  - 47% Awareness of 10 OPEX Provided to Industry Indicator;
  - 29% Awareness of 100% of Previous Years Industry OPEX Analysed;
  - 27% Awareness of sister plant Taishan Agreement Performance Indicator;

Without an effective Corrective Action Programme, performance deficiencies and adverse trends will not be addressed in a timely manner to prevent re-occurrence.

Recommendation: The plant should enhance its Corrective Action Programme to ensure performance deficiencies and adverse trends are addressed in a timely manner.

IAEA Bases:

SSR-2/2 (Rev. 1)

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

SSG-50

2.56. The types of trend (including trends in low level events and near misses) that should be identified and reviewed include the following:

(a) Recurring issues occurring in several relevant reported events;

(b) Events or issues arising particularly in certain operating modes or during certain activities;

(c) Recurring failures or degraded performance of particular systems or components;

(d) Trends in causes of identified events or issues;

(e) Adverse trends in human and organizational performance;

(f) Trends involving small incremental changes over a long period of time;

(g) Trends identified by comparing current performance to a previous similar operating condition (e.g. comparing two outages);

(h) Positive trends.

2.57 An appropriate review should be conducted in response to identified adverse trends.

2.76 The effectiveness of the operating experience programme should be assessed using methods such as self-assessment, benchmarking and independent peer reviews. Such assessment should be carried out on a regular basis by teams of experienced personnel who are familiar with the operating experience programme.

6.8. TRENDING AND REVIEW OF OPERATING EXPERIENCE

6.8(a) Good Practice – Liaison officer dedicated to Operating Experience in sister plant Taishan for in-depth sharing of OE

To ensure that Flamanville 3 has in-depth knowledge of the Operating Experience from its sister plant Taishan, a special agreement between the two plants has been established. There are 2 key elements of this agreement that enables staff to be immersed in and aware of important OPEX from Taishan.

The first key element is the presence of a liaison engineer seconded to Taishan. This liaison officer (seconded since 2016) who is paid for by EDF and FLA3, is dedicated to communicating OPEX both ways.

The liaison officer is responsible for drafting a weekly report of activities performed in Taishan and highlighting potential points of interest for FLA3. This report is analysed in-depth during a weekly conference call between the liaison engineer and the FLA3 Technical Director, OPEX Single Point of Contact and various department members. This conference call is an open discussion, which allows participants to flag and initiate OPEX actions or potentially request additional information from Taishan to FLA 3 and vice-versa.

Another element of the liaison officer role is to identify opportunities to participate and learn for first time evolutions. FLA3 staff (from technicians to engineers, as well as top management) take part in Taishan's key activities and evolutions. For instance, between January and May 2019, 16 staff members took part in operational activities in China during the start-up of Taishan 2, and the first outage of Taishan 1. These opportunities provide invaluable first-hand experience that is brought back, shared and applied when similar activities are carried out at FLA3.

Conversely 16 employees from Taishan are taking part in FLA3's commissioning activities to share their technical expertise and mentor staff.

FLA 3 has benefited from this agreement by:

- Ability to use OE from Taishan 1 & 2 hot functional tests to prepare and complete FLA3's own phase 1 hot functional tests (integrating OPEX into operations procedures and training programme).
- FLA3 Fuelling Managers attended Taishan 1 fuel load operations (opportunity to train on the EPR fuel handling machine and to identify improvements for FLA3).
- FLA3 staff have taken part in Taishan's key start-up tests.
- FLA3 staff have taken part in Taishan's first outage (set up of the core instrumentation: opportunity to improve work procedures, training needs and procurement of tools)

7. RADIATION PROTECTION

7.2. RADIATION PROTECTION POLICY

The plant has put in place several dose optimization measures and has a well-documented ALARA programme. The team noted, however, that the plant has not yet implemented dose constraints. The team made a suggestion in this area.

7.3. RADIATION WORK CONTROL

The Radiation Protection (RP) group has requested several design changes to optimize radiation exposure during operation and outages. The team recognized this as a good practice.

7.5. RADIATION PROTECTION INSTRUMENTATION, PROTECTIVE CLOTHING AND FACILITIES

Before reaching the Radiation Controlled Area (RCA), there are several change rooms that allow workers to remove their clothes and put on protective coveralls. Access to the RCA is through a single entrance that requires workers to scan their badges. The plant has installed computerized stations near the change rooms that allow the workers to check that they meet all the administrative and regulatory requirements to enter the RCA. The team identified this as a good performance.

The hot workshop is shared between Flamanville units 1, 2 and 3. It includes storage areas for contaminated items, decontamination vessels, underground storage tanks for liquid effluents, and a laundry facility. The facility is well maintained, but the decontamination area is cluttered with obsolete or decommissioned equipment that has not been removed. The team encouraged the plant to dispose of unneeded equipment.

7.6. RADIOACTIVE WASTE MANAGEMENT AND DISCHARGES

The plant has implemented a bar-code system that tracks radioactive waste from the point of generation to the eventual disposal site. The system allows real-time tracking of inventories, location and detailed information regarding the content of waste packages. The team recognized this as a good practice.

The plant has implemented a comprehensive programme to monitor radioactive and conventional discharges to the environment. The gaseous radioactive effluent monitoring system includes two duplicate chains of instrumentation which comprise:

- molecular sieves for carbon-14 in the chemical form of carbon dioxide, with an oven to oxidize methane;
- a tritium sampler with two bubblers in series;
- filters and charcoal cartridges for particulates and iodine;
- a beta proportional chamber for noble gases;
- a gamma spectroscopy system.

Radioactive liquid effluents are to be sampled from the liquid effluent tanks and analysed in a laboratory. The releases will be reported monthly and annually to the regulator and the public.

During the commissioning of the stack monitoring system, the plant is not planning to carry out tests to measure the sampling efficiency. The sampling efficiency of a stack monitoring system is determined by measuring the recoveries of various test reagents injected into the stack. The sampling efficiency is one of the largest contributors to measurement biases in the stack monitoring system. The plant reports effluent releases to the environment without uncertainties, while environmental concentrations in air and water are reported with uncertainty. The team made a suggestion regarding the assessment and reporting of uncertainties.

DETAILED RADIATION PROTECTION FINDINGS

7.2. RADIATION PROTECTION POLICY

7.2(1) Issue: The plant has not implemented dose constraints to ensure optimization of protection and safety for activities that generate occupational and public radiation exposure.

The team noted the following:

- The plant has not implemented dose constraints for occupational exposure. The EDF Corporate organization will issue a policy on dose constraints in 2020. The plant will implement this policy later.
- The plant has not proposed public dose constraints to the regulator or implemented dose constraints set by the regulator.
- The implementation of ALARA at the plant does not include dose constraints.

Without implementing the dose constraints in the plant, the protection and safety for activities that generate occupational and public radiation exposure may not optimized.

Suggestion: The plant should consider implementing dose constraints in compliance with standards requirements.

IAEA Bases:

GSR Part 3

1.22. Dose constraints and reference levels are used for optimization of protection and safety, the intended outcome of which is that all exposures are controlled to levels that are as low as reasonably achievable, economic, societal and environmental factors being taken into account. Dose constraints are applied to occupational exposure and to public exposure in planned exposure situations. Dose constraints are set separately for each source under control and they serve as boundary conditions in defining the range of options for the purposes of optimization of protection and safety. Dose constraints are not dose limits: exceeding a dose constraint does not represent non-compliance with regulatory requirements, but it could result in follow-up actions.

1.23. While the objectives of the use of dose constraints for controlling occupational exposure and public exposure are similar, the dose constraints are applied in different ways. For occupational exposure, the dose constraint is a tool to be established and used in the optimization of protection and safety by the person or organization responsible for a facility or an activity. For public exposure in planned exposure situations, the government or the regulatory body ensures the establishment or approval of dose constraints, taking into account the characteristics of the site and of the facility or activity, the scenarios for exposure and the views of interested parties. After exposures have occurred, the dose constraint may be used as a benchmark for assessing the suitability of the optimized strategy for protection and safety (referred to as the protection strategy) that has been implemented and for making adjustments as necessary. The setting of the dose constraint needs to be considered in conjunction with other health and safety provisions and the technology available.

3.25. For occupational exposure and public exposure, registrants and licensees shall ensure, as appropriate, that relevant constraints are used in the optimization of protection and safety for any particular source within a practice.

For occupational exposure, the relevant dose constraint is on individual doses to workers, established and used by registrants and licensees to set the range of options in optimizing protection and safety for the source. For public exposure, the relevant dose constraint is a source related value established or approved by the government or the regulatory body, with account taken of the doses from planned operations of all sources under control. The dose constraint for each particular source is intended, among other things, to ensure that the sum of doses from planned operations for all sources under control remains within the dose limit.

3.77. Employers, registrants and licensees:

(b) Shall establish and use, as appropriate, constraints as part of optimization of protection and safety.

7.3. RADIATION WORK CONTROL

7.3(a) Good Practice: Optimization of the design to improve occupational exposure and the effectiveness of RP facilities.

Since the beginning of construction of FLA3, the radiation protection group has analysed the way work will be carried out in the RCA and has requested several design changes to optimize radiation exposure during operation and outages. Some of the examples include:

- Installation of five portal monitors C2 and three small object monitors CPO at the exit of the RCA instead of six portal monitors C2 and two small object monitors. This modification improves the flows at the exit of the RCA and reduces the background of interference of portal monitors.
- The installation of a container full of RP equipment in the extension of the fuel building. The equipment is used to check the fresh fuel upon arrival.
- The C1-RB portal monitors were relocated at the exit of the airlock at 19.5m to maintain good contamination control.
- A room was repurposed for decontamination at the exit of the RCA.
- The water filter transfer machine adapted from Konvoy initially lacked a system to ensure negative pressure during transfers. The plant requested a system modification to deal with this inadequacy.

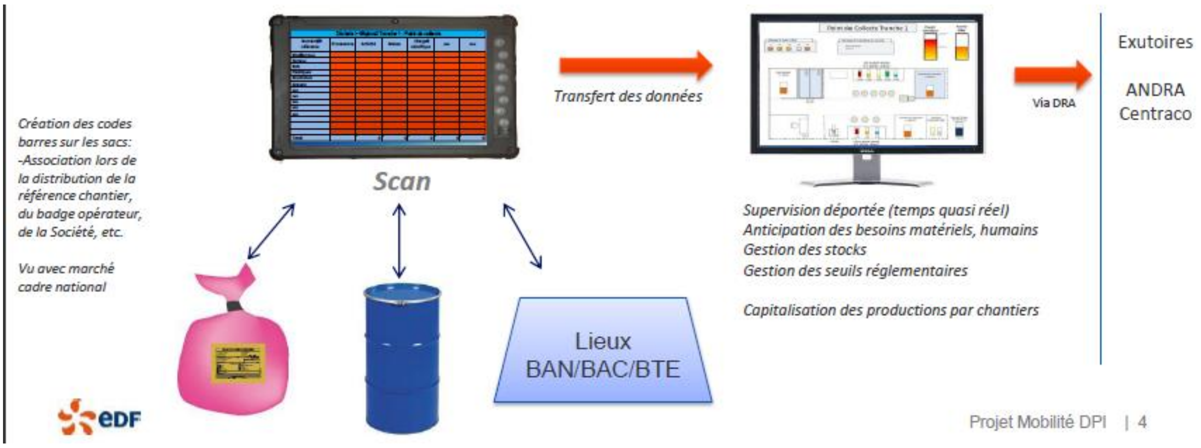
Benefits:

The design changes allow better work flow, shorter intervention times, improved radiological conditions, better contamination control and more efficient entry and exit from the RCA.

Thanks to the design changes, the modified equipment, facilities, and layouts provide noticeable improvement in the usability of the installations. This will lead to shorter stay time in high radiation areas, better shielding, and more efficient work flow resulting in reduced occupational exposure.

7.6. RADIOACTIVE WASTE MANAGEMENT AND DISCHARGES

7.6(a) Good Practice: The plant has implemented a bar-code system that tracks radioactive waste from the point of generation to the eventual disposal site. The system is called WasteApp.



At each work site, the person in charge sorts and puts the radioactive waste in bags labeled with a bar code. A tablet allows this person to scan the bag and enter information regarding the person who bagged the waste, the location of the work site, the number of the work permit, the type of waste in the bag, the dose rate on contact with the bag.

Bagged waste is then compacted into drums. Each drum is identified with a bar code. The operator uses a tablet to scan the drum and scan each bag put into the drum. Ultimately, each shipment to the ANDRA disposal site can be tracked by bar code and the full history of the waste stored at the site can be retrieved.

All of the Intermediate-Level Waste, Low-Level Waste and Very-Low-Level Waste packages (including waste bags and other types) are tracked by the application. The system provides information on where they were produced, processed, and stored (such as Nuclear Auxiliary Building, Auxiliary Waste Conditioning Building, Waste Treatment Building, Very-Low-Level Waste storage area, ANDRA).

This system allows the plant to comply with the administrative and regulatory requirements related to tracking the content of radioactive waste in an effective and efficient manner. It reduces the administrative burden associated with these tasks.

Benefits:

The system provides real-time information on the quantity of waste produced, where it is currently stored, and what it contains.

The plant can gather OPEX on the quantity of waste generated by each type of intervention on the plant's systems.

It is also possible to track the inventory of bags, containers, drums and order more when the inventory falls below a threshold.

7.6 (1) Issue: The plant's process for reporting effluent releases does not include the assessment and reporting of uncertainties to convey the quality of the results and significance of the releases.

The team noted the following:

- The plant plans to report effluent releases (activity released per month or year) without uncertainties but environmental media results (activity in air per cubic meter, activity in water per litre) will be reported with uncertainty.
- During the commissioning of the stack monitoring system, the plant is not planning to carry out tests to measure the line losses and other key parameters that define the overall uncertainty of the system. The sampling efficiency of a stack monitoring system is determined by measuring the recoveries of various test reagents injected into the stack.

Without assessing and reporting the uncertainty associated with effluent releases, the interpretation of monitoring results and dose assessment procedures may not accurately capture the quality of the results and significance of the releases.

Suggestion: The plant should consider assessing all sources of uncertainties associated with the effluent releases, and report the uncertainty associated with effluent releases.

IAEA Bases:

GSR Part 3 Requirement 14

Registrants and licensees and employers shall conduct monitoring to verify compliance with the requirements for protection and safety.

RS-G-1.8, Table 6

MONITORING QUANTITIES AND MEASUREMENT GUIDANCE include

- Gamma dose rate at the source;
- Gases in released air;
- Aerosols in released air;
- Activity in released water;

RS-G-1.8

6.35. The uncertainties in monitoring results should be determined with account taken of uncertainties in sampling and measurement procedures, including the uncertainties in sample processing parameters and equipment calibration, and they should be reported together with the monitoring results. The uncertainties in monitoring results should be taken into account in dose assessment procedures and in the interpretation of monitoring data.

8. CHEMISTRY

8.2. CHEMISTRY PROGRAMME

A chemistry manual is available at the plant as the basis for all the plant-specific chemistry parameters. To reduce dose from colbalt-60 on component surfaces during operation, zinc-injection is performed. This covers surfaces with a special stable oxide layer (spinel) which will prevent cobalt build-up at the surface of the components during normal operation, and thereby minimizes the dose. The team recognized this as a good performance.

The team noted that the plant policy for labelling hazardous chemical substances and systems is not always consistently applied to prevent adverse effects on industrial safety or the condition of equipment. For example, some bottles, containers containing fluids and pipes were not labelled correctly. The team made a suggestion in this area

8.3. MANAGEMENT OF CHEMISTRY DATA

The team noted the plant practice to manage chemistry related records does ensure their integrity. For example, during commissioning, analysis results were not documented in the plant chemistry electronic documentation system but in handwritten notes. Several records have been partly over-written or corrected with eraser. The team encouraged the plant to improve in this area.

8.4. CHEMISTRY SURVEILLANCE AND CONTROL PROGRAMME

Management of the chemistry surveillance and control programme is also facilitated by the database in which the specifications from the chemistry handbook are stored.

In chemistry, all the necessary analysis equipment is available as well as all the necessary regulations and instructions. The plant introduced an additional monitoring programme during the start-up phase. The team recognized this as a good performance.

8.5. LABORATORIES AND MEASUREMENTS

The team noted the plant capability to take post-accident gaseous and liquid sampling is not fully established to support assessment of plant conditions in case of emergency situations. For example, the procedure for taking samples during a severe accident does not provide clear instructions. There is no shielding or glove box installed for protecting the chemistry personnel while they take samples in potentially high dose rate situations. There is no facility to dilute the sample to reduce the dose rate. No training for post-accident sampling has been performed. The team made a recommendation in this area.

DETAILED CHEMISTRY FINDINGS

8.2. CHEMISTRY PROGRAMME

8.2(1) Issue: The plant policy for labelling hazardous chemical substances and systems is not always consistently applied to prevent adverse effects on industrial safety or the condition of equipment.

The team noted the following:

- The pipes are marked differently in the chemical injection room: the pipes are labelled ‘peroxide’ and the corresponding fittings are labelled ‘hydrazine’. Hydrazine is transported in the pipes. The system has not yet been transferred to the plant.
- a bottle containing a diluting solution was not labelled with the date of preparation;
- a bottle containing sulphuric acid was not labelled correctly;
- a bottle containing solution prepared for analyses was not labelled correctly;
- a bottle containing hydrochloric acid was not labelled with the date it was opened.
- Some bottles used to prepare a preliminary test and stored in a small box had partially completed labels.
- Between the diesel generator building and the fuel building (opposite the entrance to the diesel building) some containers with diesel fuel waste were stored. The containers did not have the correct hazard labelling in accordance with plant rules.
- A tank intended for ethanolamine was labelled with morpholine and ethanolamine. The system had not yet been handed over.
- Hydrazine is stored in a chemical storage cabinet, but the cabinet is not connected to the ventilation system or to an active carbon filter system

Without strict application of the policy for labelling hazardous chemical substances and systems, adverse effects on the safety of personnel and equipment may occur.

Suggestion: The plant should consider reinforcing the application of the policy for labelling hazardous chemical substances and systems to ensure the safety of personnel and plant equipment.

IAEA Bases:

SSG-13

2.9. Management of the operating organization should periodically evaluate the activities of the chemistry programme by carrying out walkdowns of chemistry facilities and checking plant chemistry equipment. Managers responsible for chemistry programme activities should monitor those indicators of staff behaviour and attitudes that show the development of a strong safety culture (e.g. proper attention to alarms, timely reporting of malfunctions, minimization of backlog of overdue maintenance, adequate labelling, accurate recording of data).

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

9.13. 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.

9.15. Chemicals should only be stored in an appropriate store that is fire protected and captures spillages and which is equipped with a safety shower, as required. Oxidizing and reducing chemicals, flammable solvents and concentrated acid and alkali solutions should be stored separately. Tanks containing chemicals should be appropriately labelled. Reasonably small amounts of chemicals can be stored in other controlled environments in the workshops or operational department.

8.5. LABORATORIES AND MEASUREMENTS

8.5(1) Issue: The plant capability to take post-accident gaseous and liquid sampling is not fully established to support assessment of plant conditions in case of emergency situations.

The team noted the following:

- The plant has a system for taking gaseous samples after an accident, however the equipment for taking samples is not available in Flamanville 3 but stored on NPP Chinon site, which is about 400km away.
- The procedure for taking liquid samples during a severe accident does not provide clear instructions on taking samples:
  - Instructions how to transport sampling equipment to the sampling point for liquid samples two floors below the ground.
  - There is no shielding or glove box installed for protecting the chemistry personnel while they take samples.
  - There is no facility to dilute the sample to reduce the dose rate.
  - A brochure with the functions of the sampling system after accidents is available, but detailed plans have not been prepared for the sampling chemistry personnel.
- No training for post-accident sampling has been conducted.

Without a fully established post-accident gaseous and liquid sampling capability, the assessment of plant conditions in case of emergency could be challenged.

Recommendation: The plant should establish the capability of post-accident gaseous and liquid sampling to support assessment of plant conditions in case of emergency situations.

IAEA Bases:

GSR Part 7

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

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;

(c) Radiological conditions on the site and, as appropriate, off the site;

SSR-2/1 (Rev.1)

Process sampling systems and post-accident sampling systems

Process sampling systems and post-accident sampling systems shall be provided for determining, in a timely manner, the concentration of specified radionuclides in fluid process systems, and in gas and liquid samples taken from systems or from the environment, in all operational states and in accident conditions at the nuclear power plant.

6.31. Instrumentation and recording equipment shall be provided to ensure that essential information is available for monitoring the status of essential equipment and the course of accidents, for predicting the locations of releases and the amounts of radioactive material that could be released from the locations that are so intended in the design, and for post-accident analysis.

SSR-2/2 (Rev.1)

5.5. A training programme for emergencies shall be established and implemented to ensure that plant staff and, as required, staff from other participating organizations possess the essential knowledge, skills and attitudes required for the accomplishment of non-routine tasks under stressful emergency conditions.

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

SSG-13

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

6.43. A post-accident sampling system or other adequate sampling facility should be ready to operate when required by emergency procedures and should also be considered for use in taking regular samples from plant systems. If a post-accident sampling system does not exist, other approaches should be adopted for core damage evaluation and for estimation of the inventory of fission products released into the containment.

SSG-25

5.124. The review should examine the following types of procedures:

– Operating procedures for normal and abnormal conditions (including anticipated operational occurrences, design basis accident conditions and post-accident conditions);

6.44. For proper operation of a post-accident sampling system, the following should be provided:

(a) Operating procedures for the post-accident sampling system.

(b) Radiation protection measures for personnel who carry out sampling and analysis; such measures should be evaluated in advance and applied when the post-accident sampling system is used.

(c) A programme for preventive maintenance;

(d) Regular checks of the operability of the post-accident sampling system;

(e) Regular training of personnel designated for operation of the post-accident sampling system (i.e. personnel taking grab samples and performing subsequent activities);

(f) Specification of the chemistry parameters to be monitored (e.g. conductivity in the reactor water cleanup system and gaseous fission products in the main steam system);

(g) Procedures for optimizing occupational radiation exposure.

8.8. Consideration should be given to training facilities and methods that are widely used and which have been proven to be effective in attaining the training objectives when appropriately chosen. Such proven facilities and methods include the following:

(b) On the job training should be conducted in accordance with written operating procedures for activities such as taking samples, controlling of water treatment technologies, using an on-line chemistry station, fixing deficiencies in on-line and off-line equipment, performing regular minor maintenance on on-line equipment and laboratory instruments, and using the post-accident sampling system.

SSG-28

A.2. The following activities and checks should be considered for completion before fuel loading:

– Availability of a post-accident sampling system;

– Availability of a post-accident radiation monitoring system;

SSG-39

8.19. “Instrumentation and recording equipment shall be provided to ensure that essential information is available for monitoring the status of essential equipment and the course of accidents, for predicting the locations of releases and the amounts of radioactive material that could be released from the locations that are so intended in the design, and for post-accident analysis.”

8.21. The set of displays for monitoring accident conditions is usually called an ‘accident monitoring system’ or a ‘post-accident monitoring system’. Such displays may be provided as part of another system or may be a collection of individual instrument channels.

9. EMERGENCY PREPAREDNESS AND RESPONSE

9.2. EMERGENCY RESPONSE

The team observed that arrangements for assembly and evacuation of on-site personnel during the emergency are not comprehensive to ensure effectiveness under all postulated situations. For instance, the team found that routes to assembly points are not signalled, these points are located in storage and warehouse areas, where heavy equipment is stored very close by, no key box is available to place the emergency equipment cabinet keys, a minimum number of buses to use during an evacuation is not ensured and there is no time estimate for the arrival of buses and effective completion of the evacuation. The team made a recommendation in this area.

The team observed that the approach to assess the radiological consequences of accidents and adapt the protection strategy is not always consistent with the graded approach defined in IAEA standards. The team found that no criteria based on effective dose are used to define different radiological emergency categories and determine the possibility of terminating the emergency and, therefore, operational intervention limits cannot be adapted, based on prevailing conditions. In addition, guidance to prioritise resources, based on the status of the different units, and guidance to shut down unaffected units, as applicable, are not available. The team made a suggestion in this area.

The team found that a dedicated taskforce is available to provide support to the plant in the event of a severe accident, ensuring the deployment of a minimum capability in terms of means and personnel within 24 hours from the accident. This taskforce is made up of different groups who periodically train on different sites of the fleet and are also integrated in the operating organisation. The different groups of this taskforce are periodically trained on different fleet sites, and spend time integrated in the operating organisation as well. The team considered as a good performance.

The team found that the authorities have delegated to the plant the responsibility to activate the off-site plan in case of an emergency potentially involving early radiological releases. Thus, the population surrounding the plant is alerted to stay at home and to listen to the news on the media. The team considered this as a good performance.

The team found that there is a maximum activation time of two hours for the emergency response organisation at corporate level. The team considered this as a good performance.

9.3. EMERGENCY PREPAREDNESS

The team observed that the training, drill and exercise program does not cover all aspects of activation and coordination of the Emergency Response Organization. For instance, the team found that only one exercise involving the isolation of the plant has been performed, and it lasted only 4 hours; activation tests are always performed during working days from 7pm to 8pm; there is no individual requirement for personnel to participate in mobilisation drills; the participation requirements do not distinguish between the “in function” and the “not-in-function” roles and no process is established to provide training when response implementing procedures are revised. The team made a suggestion in this area.

The team observed that administrative checks and arrangements are not always sufficient to ensure that resources, in terms of personnel on call and emergency documentation, remain adequate at all times. For instance, the team found that there is no requirement to warn the Emergency Director when a person on call is not reached during an activation test; no specific criteria are in place to ensure fitness for specific emergency response duties assigned to personnel; and no procedure is in place to contact relatives and provide them with detailed information on emergency workers' health status. Furthermore, no forms are in place to record the replacement of emergency response implementing procedures and to record the hand-over of the folder containing the procedures that key positions on call must have at all times. The team made a suggestion in this area.

The team found that the site has an emergency response centre that provides protection for emergency responders against a wide spectrum of adverse conditions, including high radiation levels and earthquakes. This centre is intended to store portable equipment used to support the operational response, therefore, minimising the movement of personnel throughout the site. The team considered this as a good practice.

The team found that badge readers are available in the assembly points to control not only the arrival of personnel to the point but also their departure. This facilitates the traceability of personnel during movements, for instance, for evacuation. The team considered this as a good performance.

The team found that a truck is available on-site for rescue and initial response teams to set a command post in the field and perform fire-fighting, first aid provision, and other required actions. The team considered this as a good performance.

DETAILED EMERGENCY PREPAREDNESS AND RESPONSE FINDINGS

9.2. EMERGENCY RESPONSE

9.2(1) Issue: Arrangements and means for assembly and evacuation of on-site personnel are not comprehensive to ensure effectiveness under all postulated emergency conditions, including during early stages of an emergency.

The team noted the following:

- A survey of 10 people on the subject of emergency alarms yielded the following results:
  - None were able to identify the general site alarm from memory;
  - 4 out of 10 did not realize the information is available on their badges;
  - 6 out of 10 were not able to identify the closest assembly point, although they all know the biggest one, usually utilized in drills.
- Currently, there are no signs in the construction area indicating the way to assembly points.
- The four assembly points on-site for Flamanville 3 are located in either workshop or warehouse areas, storing heavy electrical and mechanical equipment, with low isolation capacity, and without fixed radiation monitors to ensure continuous monitoring at all moments; in 2 of the 4 assembly points, materials were found in front of or by the cabinets with emergency equipment and the badge readers; in 1 of the 4 assembly points, one device to detect contamination was missing.
- Assembly points are equipped with masks to limit (to a certain extent but not completely prevent) the ingestion and inhalation of particles; but no contamination protection clothes, delimiting and signalling tools, nor other means to prevent contamination spreading, nor spare batteries for electrical equipment, are available in the assembly points.
- Cases with cabinet keys are not available in the assembly points to ensure accessibility to emergency means stored in the cabinets.
- The inventory list in the assembly points does not include the water bottles and the toxicity masks. The frequency for checking emergency means in the assembly points is not established, and no official form with a checklist is available.
- The calibration of devices to check radiological conditions stored in the cabinets in assembly points is managed through a system to control the inventory of equipment and materials stored on-site, in accordance with a procedure which includes the requirement to warn the user of the device on-site of the need to return the device for calibration. However, currently, the person assigned in the system as the device user is not the person responsible for the devices (the emergency preparedness specialist).
- The minimum inventory list of medical assistance means was not defined at the time of the mission.
- The required surveillance frequency of emergency protective equipment for emergency responders is only once per year. It was stated that additional checks are to be performed before each exercise, but this instruction in not written in a procedure.

- No procedure exists defining the instructions for personnel to follow once an emergency alert is triggered.
- No expectation exists for personnel to take car keys with them when moving to assembly points following the triggering of the emergency alarm. As a result, if evacuation is warranted, personnel may need to come back for keys or take a bus to be evacuated.
- Personnel responsible for ensuring control and safety in assembly points are not assigned dedicated mobile communication devices (TETRA) to ensure communication in all circumstances.
- The time needed for the buses to arrive on the site in the event of evacuation has not been calculated and there is no specific procedure or agreement to ensure that a minimum number of buses is available to be deployed on-site.
- No evacuation drill involving the whole plant personnel has ever been performed, and partial evacuation drills include only moving personnel to a fallback centre within 7 kilometres from the plant, but not outside of the 10-kilometer planning zone.
- The fallback centre, intended for assembling the personnel evacuated from the site, is not equipped with means to avoid contamination spreading; no dedicated TETRA devices are stored for bus drivers to ensure communication and coordination during the evacuation.
- No specific protective equipment is pre-defined and pre-located for bus drivers to take when approaching the site to collect personnel during evacuation.

Without having comprehensive arrangements for assembly and evacuation of on-site personnel, these actions may not be performed in a prompt and effective way to minimize hazards.

Recommendation: The plant should improve the arrangements and means for assembly and evacuation of on-site personnel, to ensure their effectiveness under all postulated emergency conditions, including during early stages of an emergency.

IAEA Basis:

GSR Part 7

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;

(d) Protection of emergency workers and helpers in an emergency.

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

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

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

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

(d) To provide immediate first aid;

(e) To take urgent protective actions.

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

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

(b) A sufficient number of suitable escape routes;

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

9.2(2) Issue: The plant practices to assess the radiological conditions is not always comprehensive.

The team noted the following:

- There are two criteria to declare the emergency based on activities from process monitors, but there is no criterion based on radiation levels or total effective dose. In addition, the emergency classification system is not graded based on total effective dose estimates.
- Regarding the criteria to terminate the emergency, a criterion consisting in ensuring the releases are arrested is used, but there is no criterion based on residual dose.
- No written guidance exists on criteria to interact with unaffected units during the emergency.
- There is no written guidance in emergency response implementation procedures to prioritize resources in case of a multi-unit event.
- Regarding the capability to perform dose estimations, tables showing the effective dose due to releases for a wide spectra of accidents are available individually for each unit, but there is no capability on-site to perform an actual estimation based on process monitor readings and environmental surveillance data; this calculation is done at the corporate level, whose personnel are only required to be ready within two hours.
- No evidence of use of Probabilistic Safety Assessment Level 2 in the definition of postulated emergency events was provided.

Without having a comprehensive approach to assess the radiological consequences the prioritization of actions may not be realized in a timely manner.

Suggestion: The plant should consider improving the practices for assessment of radiological conditions.

IAEA Bases:

GSR Part 7

4.23. In the hazard assessment, facilities and activities, on-site areas, off-site areas and locations shall be identified for which a nuclear or radiological emergency could — with account taken of the uncertainties in and limitations of the information available — warrant any of the following:

(a) Precautionary urgent protective actions to avoid or to minimize severe deterministic effects by keeping doses below levels approaching the generic criteria at which urgent protective actions and other response actions are required to be undertaken under any circumstances, with account taken of Appendix II;

GSR Part 7

4.31. The government shall ensure that the protection strategy is implemented safely and effectively in an emergency response through the implementation of emergency arrangements, including but not limited to:

(f) Assessing the effectiveness of the actions taken and adjusting them as appropriate on the basis of prevailing conditions and available information as well as the reference level expressed in terms of residual dose;

GSR Part 7

5.14. The operating organization of a facility or activity in category I, II, III or IV shall make arrangements for promptly classifying, on the basis of the hazard assessment, a nuclear or radiological emergency warranting protective actions and other response actions to protect workers, emergency workers, members of the public and, as relevant, patients and helpers in an emergency, in accordance with the protection strategy (see Requirement 5). This shall include a system for classifying all types of nuclear or radiological emergency as follows:

(a) General Emergency;

(b) Site Area Emergency;

(c) Facility Emergency;

(d) Alert.

Note: The emergency classes may differ from those specified in (a)–(e) provided that emergencies of all these types are included.

GSR Part 7

5.58. Arrangements shall be made to assess as soon as practicable the individual doses received in a response to a nuclear or radiological emergency by emergency workers and helpers in an emergency and, as appropriate, to restrict further exposures in the response to the emergency (see Appendix I).

GS-G-2.1

4.17. OILs should be developed for radioactive releases and/or direct exposures resulting from emergencies involving facilities in threat categories I, II and III and for radiological emergencies, by using realistic assumptions and including arrangements to revise the OILs as appropriate to take into account the conditions prevailing during the emergency.

GSG-2

5.6. Reference [2], in para. 4.71, states that “arrangements shall be made for promptly assessing the results of environmental monitoring and monitoring for contamination on people in order to decide on or to adapt urgent protective actions to protect workers and the public, including the application of operational intervention levels (OILs) with arrangements to revise the OILs as appropriate to take into account the conditions prevailing during the emergency.” In addition, para. 4.89 of Ref. [2] states that default OILs shall be established together with the means to revise the OILs for “environmental measurements (such as dose rates due to deposition and deposition densities) and food concentrations; the means to revise the OILs; timely monitoring...for ground contamination in the field; the sampling and analysis of food and water; and the means to enforce agricultural countermeasures.”

5.10. The dosimetric models for developing the OILs should be established during the planning phase. These models should include a full set of parameters important for the purposes of decision making for dose assessment. For internal dose assessment and the development of corresponding OILs, the application of computer codes is necessary.

5.12. These default OILs should be developed on the basis of assumptions regarding the emergency, the affected population and the prevailing conditions; these assumptions, however, may not accurately reflect the emergency in question. Consequently, Ref. [2] requires that means be established to revise the default OILs to take into account prevailing emergency conditions. However, revising the OILs during an emergency may be disruptive, and they should therefore only be revised if the situation is well understood and there are compelling reasons to do so. The public should be informed of the reasons for any change in the OILs applied in an actual emergency.

Table 12. Emergency Classification for Light Water Reactors in Operating, Standby or Hot Shutdown Mode

9.3. EMERGENCY PREPAREDNESS

9.3(1) Issue: The training, drill and exercise programme does not cover all aspects of the activation and coordination of the emergency response organization to ensure response actions are performed in a prompt and effective manner.

The team noted the following:

- When a potential indication of emergency is identified by the duty shift, the Shift Manager contacts the duty Emergency Director to declare the emergency based on identified conditions. This needs to be done from off-site if the emergency arises outside of working hours, using procedures which must always be immediately available for the emergency director. However, this part of the process has never been tested in exercises from off-site.
- Although the ‘in-function’ and the ‘not-in-function’ roles in the emergency organisation are actually different and performed according to different procedures, the requirement for minimum frequency of participation does not take into account the role that each participant takes.
- There is no written requirement on executing emergency response organization activation tests at different times and at weekends, and no evidence of executing emergency response organization activation tests in a time period other than 19:00-20:00 on working days was provided.
- Only two mobilization drills are required to be performed each year, and there is no requirement for each person, and, therefore, someone may never participate in a mobilization drill.
- Regarding exercises under extreme conditions, only one exercise has been performed (in 2016), considering the isolation of the plant for a 24 hour period, which is a postulated condition. The exercise lasted only four hours and did not include the organization of shift relief to demonstrate the capability of avoiding disruption in the deployment of response actions during the first 24 hours.
- No pre-defined objectives exist to ensure a systematic assessment of performance during exercises.
- There is no written requirement to include radiological implications in fire exercises; only one exercise which included some radiological considerations has been performed so far.
- There is no written guidance or form to assess the need to provide training to Emergency Response Organisation staff following changes in emergency response implementation procedures.
- Regarding the location of emergency plan implementing procedures in the main control room, it was stated that currently there are some slight differences in the configuration between this room and the simulator. As a result, the final location is not defined yet.
- During an emergency, the field operators are to stand by for instructions in the main control room area, which is protected with ventilation, and equipped with protective equipment. However, no exercises have been performed involving contamination of field operators and the need to take them to the emergency management centre for decontamination.

Unless the training, drill and exercise programme covers all aspects of the activation and coordination of the emergency response organization, some response actions may not be performed in a prompt and effective manner during an actual emergency.

Suggestion: The plant should consider enhancing the training, drill and exercise programme to cover all aspects of the activation and coordination of the emergency response organization.

IAEA Bases:

GSR Part 7

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

6.30. Exercise programmes shall be developed and implemented to ensure that all specified functions required to be performed for emergency response, all organizational interfaces for facilities in category I, II or III, and the national level programmes for category IV or V are tested at suitable intervals. These programmes shall include the participation in some exercises of, as appropriate and feasible, all the organizations concerned, people who are potentially affected, and representatives of news media. The exercises shall be systematically

evaluated (see para. 4.10(h)) and some exercises shall be evaluated by the regulatory body. Programmes shall be subject to review and revision in the light of experience gained (see paras 6.36 and 6.38).

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

SSR-2/2 (Rev.1)

5.5. A training programme for emergencies shall be established and implemented to ensure that plant staff and, as required, staff from other participating organizations possess the essential knowledge, skills and attitudes required for the accomplishment of non-routine tasks under stressful emergency conditions.

NS-G-2.8

4.34. Training should be provided for all staff members who have assignments under the emergency plan. The training for emergencies should include the periodic performance of emergency drills and exercises. Training should also include conventional safety, in particular in fire fighting and medical first aid. Periodic drills and exercises should be held to reinforce training and to assess the effectiveness of the emergency response capability. There should be full scale exercises involving external organizations such as the police, fire services, ambulance teams, rescue teams and other emergency services.

9.3(2) Issue: Administrative checks for documentation traceability and the emergency response organization on call arrangements are not always sufficient to ensure adequate emergency resources are maintained at all times.

The team noted the following:

- There is no instruction to notify the Emergency Director on call if a person on call is not reached during a test, so a replacement can be found.
- Although there is a process to manage the replacement of the emergency response organization personnel on call, when it is known that they will be unavailable during their assigned period, there is no procedure for this process.
- There are three communication means to activate the emergency response organization: pager, cell phone and land line, but all of them rely on conventional infrastructures and it is not mandatory for members of the emergency response organization to have a cell phone.
- There is no written instruction for emergency response organization members on call to proactively try to communicate or travel to the site in the event of a situation being identified near the plant that may have affected the site, and may have caused a loss of conventional communications, therefore impeding the activation of the staff.
- Emergency responders must agree to receive doses above occupational limits when performing emergency tasks. However, there is no official form to record the willingness of emergency responders and no expectation is set to have a written agreement.
- A fitness-for-duty checking programme is in place for the operating organization, but it does not consider explicitly the assessment of fitness for duties performed during emergencies.
- There is no procedure in place to provide for dedicated information to emergency responder relatives during an emergency.
- There is no official distribution list for each emergency response procedure and there is no official form to record the effective replacement of revised documents in emergency folders.

Without having appropriate administrative checks for documentation traceability and arrangements for the emergency response organization on call, the adequacy of some resources may be challenged, reducing their effectiveness during emergency response.

Suggestion: The plant should consider enhancing the administrative checks for documentation traceability and the arrangements for emergency response organization on call to ensure that these are maintained at an adequate level at all times.

IAEA Bases:

GSR Part 7

6.9. Personnel who are assigned to positions in all operating organizations and response organizations to perform the functions necessary to meet the requirements established in Section 5 shall be qualified and shall be assessed for their initial fitness and continuing fitness for their intended duties.

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

GSR Part 7

6.18. The appropriate responsible authorities shall ensure that Emergency plans and procedures are periodically reviewed and updated

GSR Part 7

6.36. Arrangements shall be made to maintain, review and update emergency plans, procedures and other arrangements and to incorporate lessons from research, operating experience (such as in the response to emergencies) and emergency exercises.

9.3(a) Good Practice: On-site Emergency Control Centre designed with long-term habitability capability without any restrictions to withstand extreme external hazards and adverse radiological conditions.

The Flamanville 3 On-Site Emergency Control Centre (CCL) houses the facilities from where the teams perform their emergency response tasks. It also provides protection from radiological hazards.

The CCL is designed to resist any type of extreme external hazard (earthquakes, flooding, natural phenomenon associated to flooding and tornadoes).

The CCL is also self-contained in the eventual need for:

- Electrical supply: the CCL has an emergency backup generator (GES) for electrical supply. This GES can run at full load for 72 hours before refuelling.
- Food and water: the CCL contains a supply of drinking water and a stock of food that can last 72 hours;
- Protective equipment for the staff.

The CCL is designed to ensure the protection of the staff and equipment inside against radiation, irradiation and contamination, caused by events that have led to the on-site emergency response plan being triggered.

Since high efficiency filter to filer air from outside, the intake flow can always be maintained, there is no need to isolate the CCL building, which means that habitability is ensured in the long term without any restrictions even under severe accident conditions.

The CCL can accommodate the 120 on-site command posts that are needed to manage an emergency situation. A large amount of information concerning the unit parameters arrives to the facility, directly sent from the installations through secure communication links. The size also makes it possible to accommodate the command post of the FARN (Rapid Response Nuclear Task Force).

Lastly, the CCL is used to store the on-site mobile emergency equipment to ensure its protection from any external hazards and minimize the movement of responders for its deployment. It is also equipped with telecommunication systems and support equipment for the command posts, body contamination monitoring and radiological condition measurements.

10. ACCIDENT MANAGEMENT

10.4. DEVELOPMENT OF PROCEDURES AND GUIDELINES

The plant applies a single tool from the entry into the mitigatory domain up to the stabilization of a severe accident that allows the plant state to be determined and tracked by means of concise and simple diagnostics. The aim is to identify the necessary mitigation actions and enable their execution. This new concept of diagnosis contains an easily used framework such as a looping flowchart for continuous monitoring of the three severe accident safety functions. This framework, called the ‘mitigation matrix’, allows parallel consideration of the actions and sets the priorities to avoid conflict issues. The team considered the mitigation matrix as a good practice.

10.5. PLANT EMERGENCY ARRANGEMENTS WITH RESPECT TO SAM

The baseline accident management approach of the Flamanville 3 EPR has been defined. It contains the preventive domain with focus on ensuring sufficient core cooling. If the core heats up, the transition takes place to the mitigatory domain, where the focus is set on mitigating the releases, ensuring the containment integrity and cooling of the core debris. Concurrent severe accidents affecting multiple units simultaneously are considered to be highly unlikely and therefore they are not considered in the baseline SAM. Consequently, the SAM procedures do not consider coping with the concurrent severe accidents, and exercises and drills have not covered the situations of the units on-site having severe accidents simultaneously. The team made a suggestion in this area.

DETAILED ACCIDENT MANAGEMENT FINDINGS

10.4. DEVELOPMENT OF PROCEDURES AND GUIDELINES

10.4(a) Good Practice: Mitigation matrix

The mitigation matrix is a tool used to prioritize mitigation sheets and to provide a summary of plant conditions. This matrix can be accessed by members of the technical support group (ELC), ETC-N (corporate technical support team) and PCD1 (Emergency Director).

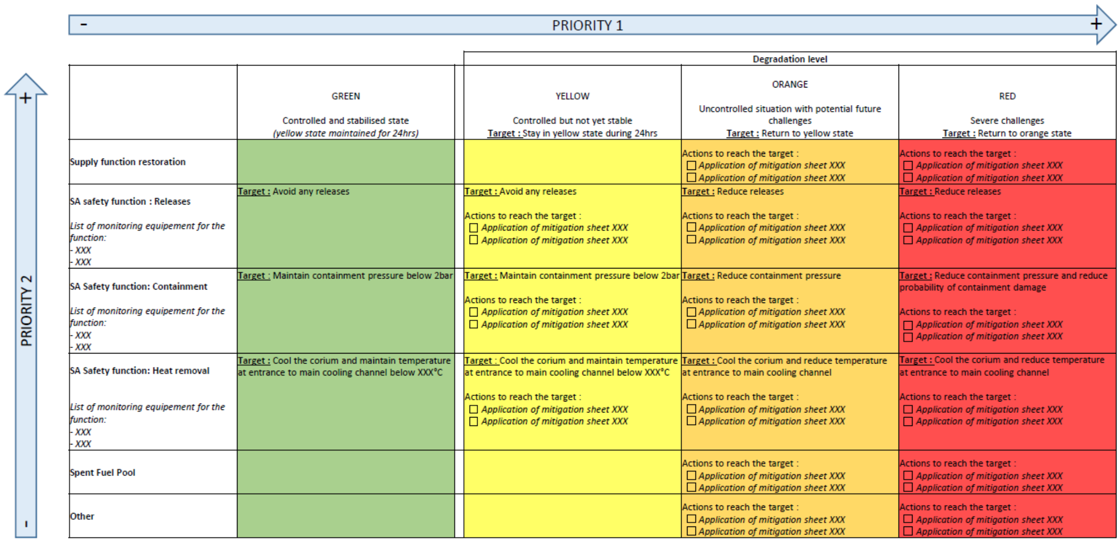
The matrix is composed of a dual input table: the severe accident safety functions (having the priority order: Release, Containment, Cooling) and the plant conditions. The colours designate the degradation levels:

– Green: conditions controlled and stabilized (post-accident phase);

– Yellow: conditions controlled but not stabilized (objective: remain in yellow status for 24 hours);

– Orange: potential hazard, anticipated risk (objective to return to yellow status);

– Red: confirmed hazard (objective: return to orange status).



PRIORITY 1 (- → +)

PRIORITY 2 (- → +)

	GREEN Controlled and stabilised state *(yellow state maintained for 24hrs)*	Degradation level YELLOW Controlled but not yet stable Target : Stay in yellow state during 24hrs	ORANGE Uncontrolled situation with potential future challenges Target : Return to yellow state	RED Severe challenges Target : Return to orange state
Supply function restoration			Actions to reach the target : ☐ *Application of mitigation sheet XXX* ☐ *Application of mitigation sheet XXX*	Actions to reach the target : ☐ *Application of mitigation sheet XXX* ☐ *Application of mitigation sheet XXX*
SA safety function : Releases *List of monitoring equipement for the function:* *- XXX* *- XXX*	Target : Avoid any releases	Target : Avoid any releases Actions to reach the target : ☐ *Application of mitigation sheet XXX* ☐ *Application of mitigation sheet XXX*	Target : Reduce releases Actions to reach the target : ☐ *Application of mitigation sheet XXX* ☐ *Application of mitigation sheet XXX*	Target : Reduce releases Actions to reach the target : ☐ *Application of mitigation sheet XXX* ☐ *Application of mitigation sheet XXX*
SA Safety function: Containment *List of monitoring equipement for the function:* *- XXX* *- XXX*	Target : Maintain containment pressure below 2bar	Target : Maintain containment pressure below 2bar Actions to reach the target : ☐ *Application of mitigation sheet XXX* ☐ *Application of mitigation sheet XXX*	Target : Reduce containment pressure Actions to reach the target : ☐ *Application of mitigation sheet XXX* ☐ *Application of mitigation sheet XXX*	Target : Reduce containment pressure and reduce probability of containment damage Actions to reach the target : ☐ *Application of mitigation sheet XXX* ☐ *Application of mitigation sheet XXX*
SA Safety function: Heat removal *List of monitoring equipement for the function:* *- XXX* *- XXX*	Target : Cool the corium and maintain temperature at entrance to main cooling channel below XXX°C	Target : Cool the corium and maintain temperature at entrance to main cooling channel below XXX°C Actions to reach the target : ☐ *Application of mitigation sheet XXX* ☐ *Application of mitigation sheet XXX*	Target : Cool the corium and reduce temperature at entrance to main cooling channel Actions to reach the target : ☐ *Application of mitigation sheet XXX* ☐ *Application of mitigation sheet XXX*	Target : Cool the corium and reduce temperature at entrance to main cooling channel Actions to reach the target : ☐ *Application of mitigation sheet XXX* ☐ *Application of mitigation sheet XXX*
Spent Fuel Pool			Actions to reach the target : ☐ *Application of mitigation sheet XXX* ☐ *Application of mitigation sheet XXX*	Actions to reach the target : ☐ *Application of mitigation sheet XXX* ☐ *Application of mitigation sheet XXX*
Other			Actions to reach the target : ☐ *Application of mitigation sheet XXX* ☐ *Application of mitigation sheet XXX*	Actions to reach the target : ☐ *Application of mitigation sheet XXX* ☐ *Application of mitigation sheet XXX*

XXX mean procedures already exist in the plant.

The matrix also targets priorities: priority 1 is assigned to the highest level of degradation and priority 2 to the 'Release' safety function. In addition, the matrix indicates the criteria for transition from one degraded level to another. For example, containment pressure is a criterion that is used to visualize any changes in the ‘containment’ safety function. Human and Organizational Factor testing showed that the matrix provided emergency response managers with a shared and synchronized representation of the severe accident management status, assisting with the objectives of controlling off-site release and of returning to a controlled state.

Benefit: The matrix enables emergency staff to visualize plant conditions more rapidly. It helps in selecting the appropriate mitigation sheet to be used once the diagnosis has been performed.

10.5. PLANT EMERGENCY ARRANGEMENTS WITH RESPECT TO SAM

10.5(1) Issue: The current scope of the severe accident management programme does not consider concurrent multiple unit accidents on-site.

The team noted the following:

- Multiple unit concurrent severe accidents are not considered as a baseline for Flamanville 3 severe accident management (SAM).
- The procedures do not consider coping specifically with the concurrent multi-unit severe accidents.
- There have been exercises on the Flamanville site involving all three units, but with only one of the units facing severe accident conditions. The plant has not carried out exercises that cover concurrent severe accidents in all three units on-site.
- The accessibility estimates for local SAM actions do not consider concurrent severe accidents. In the event of a severe accident in Flamanville 3, dose estimates are only produced for Unit 3. However, the habitability design of emergency response rooms (site emergency centre CCL and main control room) considers a severe accident on Unit 1 or 2.
- FARN's practices to ensure diesel fuel usability might be challenged, since the fuel's useable temperature range is not sufficient for external hazards such as extreme cold.
- PSA level 2 does not cover all external hazards which could affect multi units. The PSA level 1 already includes loss-of-offsite power and loss of ultimate heat sink that are often consequences of an external hazard. Thus, considerations in those parts expands implicitly to PSA level 2 domain.

By not considering that severe accidents may occur concurrently on-site, where the three units are located near to each other, some mitigation actions may not be performed in a prompt and effective manner.

Suggestion: The plant should consider enhancing the severe accident management programme with consideration of concurrent multiple unit accidents on-site.

IAEA Bases:

SSR-2/2 (Rev. 1)

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

SSG-54

2.65. For a multiple unit nuclear power plant site, the accident management programme is required to consider concurrent accidents affecting multiple units, in accordance with para. 5.8A of SSR-2/2 (Rev. 1) [6].

2.66. Accident management guidance should include the equipment and supporting procedures necessary to respond to accidents that might affect multiple units on the same site and last for extended periods of time. Personnel should have adequate skills to use such equipment and implement supporting procedures, and adequate staffing plans should be developed for emergency response at sites with multiple units.

2.67. Some events, especially natural hazards, may result in similar challenges to all units on the site. Therefore, staffing plans should take into account situations in which multiple units at the same site have been affected simultaneously and some plant personnel have been temporarily or permanently incapacitated.

2.70. The effectiveness of equipment and the emergency response facilities (e.g. the main control room, the technical support centre) that are shared by different units should be assessed for cases in which accidents, including accidents more severe than the design basis accidents, occur simultaneously at several units.

2.72. When other units are located at a neighbouring site close to the site at which a severe accident has occurred, the sharing of information with the operating organizations of those neighbouring units should be considered. Such communication would help to determine whether expected dose rates and other environmental conditions due to dispersion of radioactive material from the site at which the accident has occurred might affect access to units at the neighbouring site.

2.73. The accident management guidance should address the possibility that more than one unit, or all units, might be affected concurrently by simultaneous accidents, including the possibility that damage will propagate from one unit to another or that damage to one unit will be caused by actions taken at another unit.

2.74. When installing equipment (both permanent and non-permanent equipment) for use in severe accident management, consideration should be given to the possibility of severe accidents occurring simultaneously at more than one unit.

2.94. For multiple unit sites, the on-site emergency plan should include the necessary interfaces between the various parts of the overall on-site emergency response organization responsible for different units. Emergency directors for each unit may be assigned to decide on the appropriate actions at specific units. In this case, an overall emergency director should also be assigned to coordinate activities and priorities among all affected units on the site. Decision making responsibilities should be clearly defined. If there are different operating organizations at a given site, appropriate arrangements should be established for the coordination of emergency response operations, including accident management measures, among those organizations.

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.

3.106. All phenomena (e.g. thermohydraulic and structural phenomena) important for the assessment of challenges to the integrity of barriers against releases of radioactive material, as well as for the assessment of the source term, should be addressed. For a multiple unit nuclear power plant site, concurrent accidents affecting all units should be analyzed.

11. HUMAN-TECHNOLOGY-ORGANIZATION INTERACTION

11.2 HUMAN FACTORS MANAGEMENT

The team noted that the plant, together with the corporate organization, has implemented a comprehensive and holistic Human Factors approach. Experts in multiple disciplines including designers; human factors specialists; future operators; and instructors have been consulted to improve design, human-machine interfaces (HMI), documentation and the plant organization. Furthermore, socio-organizational and human analyses have been used to anticipate which activities of plant personnel will be affected by specific changes, how the work practices will alter, what risks are incurred or caused by the change and the future work quality for affected employees. The Human Factors achievements of the plant were considered by the team as a good practice.

The plant has been running a Human Performance programme since 2010 and six Human Performance (HU) tools have been chosen by the corporate organization for use across the EDF fleet. The requirements on use of HU tools are documented in an organizational note and there are three different levels of training. Level one training is given to all employees, while managers and HU champions also receive level two and three training. Good examples of the use of HU tools were identified during the review, but the team also identified some situations where the tools were not used in an appropriate manner and some situations where the tools should have been used but were not. The team encouraged the plant to improve the use of the HU tools.

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

The Plant has not established a knowledge management programme to ensure the effective retention and transfer of specific knowledge to support the prolonged safe operation of the plant. There were no relevant management expectations, processes and procedures on how to collect, retain and share critical safety-important knowledge within the plant. In many cases, Just-In-Time sessions and one-off commissioning activities were not captured in training databases as unique knowledge and know-how for further use. The plant has no practice to interview experienced staff to define unique knowledge not included in formal lists of professional competences. The team made a suggestion in this area.

11.5 SAFETY CULTURE

The self-assessment of safety culture should cover the entire organization and several different self-assessment tools should be used to determine the status of the safety culture of the plant. According to the IAEA standards, the independent assessment of safety culture should follow a similar approach and the independence of the members of the assessment team is considered crucial. Several initiatives, such as an annual safety assessment, have been implemented by the plant and corporate organization to assess safety and safety culture. The team noted however that neither the corporate nor the plant procedures include requirements that ensure the systematic use of multiple data collection tools when conducting a safety culture self-assessment. No independent safety culture assessment, other than by the EDF corporate organization, has been conducted at the plant and there are no clear requirements for such assessments in the management system. The team encouraged the plant to conduct fully independent safety culture assessments and ensure that broad and diverse sources of information are systematically utilized in the self-assessments, to ensure that safety culture issues are identified.

DETAILED HUMAN-TECHNOLOGY AND ORGANIZATION INTERACTION FINDINGS

11.2 HUMAN FACTORS MANAGEMENT

11.2 (a) Good practice: Effective implementation of a holistic Human Factors approach throughout the life cycle of the plant to ensure safe operation.

In cooperation with the corporate organization, FLA3 has ensured that Human Factors aspects will be considered throughout the life cycle of the plant. Human Factors has not only been taken into consideration in control room modifications, but also in maintenance activities and in the development of severe accident management (SAM) documents. Experts in multiple disciplines including designers, human factors specialists, future users/operators and instructors have been consulted for more than 18 years. The consultations and assessments have resulted in corrective actions such as Human-Machine Interfaces (HMI) advancements, clearer documentation, improvements related to ergonomic aspects and organizational improvements to ensure safe operation. Examples of improvements made by the plant:

Control room

- Better defined functionalities of operational HMI, such as the degree of automation, operator aids and the design features of operational displays for: plant status, control systems, electronic procedure visualisation also allowing management supervision, alarm visualisation and prioritisation, etc.
- Improved ergonomics of the main control room with 4 wall mounted screens which make it possible to perform real-time monitoring and allows the shift manager to have an immediate understanding of both reactor mode and operating conditions.

Maintenance activities

- To avoid having to climb down a ladder to the reactor and fuel cavities wearing a fully ventilated breathing suit, special doors have been designed and installed at the bottom of the cavities
- Increased diameter of steam generator manholes for easier access to steam generators and for reduced radiation exposure
- Improved lighting conditions for safer maintenance activities and reduced radiation exposure thanks to increased efficiency and reduced working hours
- To prevent people from going to the wrong train, room or piece of equipment, the signage rules have been changed to ensure easier and safer plant orientation and equipment identification

Severe Accident Management

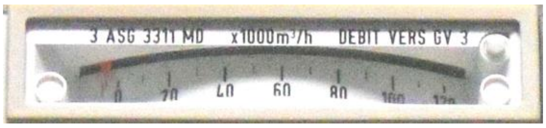
- Creation of a Severe Accident Operating Guidelines orientation document that can be used for the entire SAM process and guide the operators to the procedure that is most suited to the unit conditions.

Furthermore, socio-organisational and human (SOH) analyses have been used to anticipate which activities of plant personnel will be affected by specific changes, how the work practices will alter, what risks are incurred or caused by the change and the future work quality for affected employees. Other SOH activities include studies during Crew Performance Observation (CPO) and emergency preparedness drills to evaluate safety related factors to improve human performance. In-depth event investigations have been performed to identify, and correct weak lines of defence and socio-psychological studies have also been conducted to guarantee a work environment which supports safe performance.

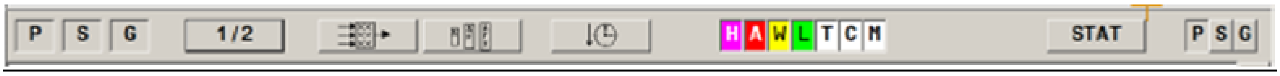
Photos of some of the improvements made at the plant:

Before improvements - Standard display unit (difficult to read for people of shorter stature)

After improvements - New display units with the requested modifications

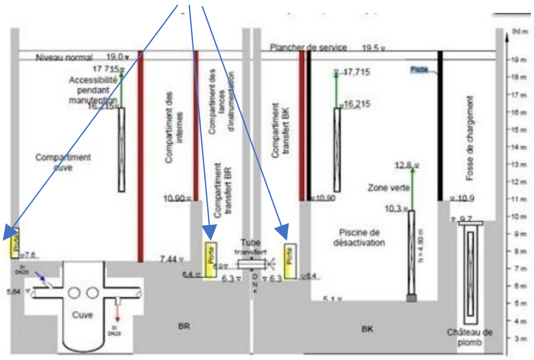


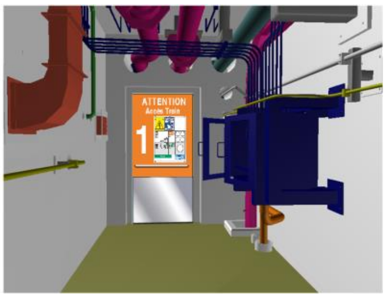
Alarm list menu and headers before improvements - Standard menu



Alarm list menu and headers after improvements - EPR FA3 menu

This picture illustrates the three special doors that have been installed at the bottom of the cavities.





Signage improvement (colour specific) to prevent people from going to the wrong safety train (before the improvements there was only a number)

Picture of the main control room with 4 wall mounted screens which make it possible to perform real-time monitoring.

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

11.4(1) Issue: The plant has not established a knowledge management programme to ensure the effective retention and transfer of specific knowledge to support the prolonged safe operation of the plant.

The team noted the following:

- There were no plant expectations regarding a knowledge management programme.
- There was no plant procedure, which described how to collect, retain and share critical safety-important knowledge within the plant.
- There was no documented knowledge management process within the Integrated Management System (IMS). In addition, planned and coached knowledge transfer was based on ad hoc solutions, and inconsistently applied based on individual management decisions when one employee planned to leave the organization.
- There were no plant-level KPIs for the knowledge management process.
- The plant has no practice for systematically capturing knowledge related to one-off commissioning activities and safety-related work such as embedded structures in the reactor building, and critical contractor activities such as testing of safety-related equipment. The related expectations were therefore not considered as elements of knowledge management and were not consistently documented and stored.
- Just-in-time training (JIT) on specific topics was not captured in training databases as knowledge and know-how for further use.
- In some cases, the plant staff did not know how to find construction design data gathered from the company's own plants and from similar plants.
- The plant has no practice of interviewing experienced staff to capture individuals' knowledge not included in formal lists of professional competences.
- There was no list of experts as owners of important safety-related knowledge.

Without an effective knowledge management programme, retention and transfer of specific knowledge to support prolonged safe operation of the plant could be challenged.

Suggestion: The plant should consider establishing a programme for specific knowledge management to support the prolonged safe operation of the plant.

IAEA Bases:

GSR Part 2

4.1. Senior management shall determine the amount of resources necessary and shall provide the resources to carry out the activities of the organization and to establish, implement, assess and continually improve the management system.

4.2. The information and knowledge of the organization shall be managed as a resource.

5.22. Retention times of records and associated test materials and specimens shall be established to be consistent with the statutory requirements and knowledge management obligations of the organization.

GS-G-3.1

4.2. To improve the performance of the organization, consideration should be given to the way resources are managed. This should include:

- Effective, efficient and timely provision of resources in the context of the opportunities and constraints;

- Use of information management, knowledge management and the corresponding technology

4.4. Data should be converted to information for the continual development of an organization's knowledge, and senior management should treat information as a fundamental resource that is essential for making factually based decisions and stimulating innovation. To manage information and knowledge, senior management:

– Should identify the organization's information needs;
– Should identify and access internal and external sources of information;
– Should convert information to knowledge of use to the organization;
– Should use the data, information and knowledge to set and meet the organization's strategies and objectives;
– Should ensure appropriate security and confidentiality;
– Should evaluate the benefits derived from the use of the information in order to improve the management of information and knowledge;
– Should ensure the preservation of organizational knowledge and capture tacit knowledge for appropriate conversion to explicit knowledge.

NS-G-2.8

4.1. The operating organization is responsible for training its own staff and ensuring that contractors' staff are suitably trained and experienced so that all work is carried out safely.

13. COMMISSIONING

13.1 THE COMMISSIONING PROCESS

The plant has implemented some processes to support the interaction in-between Operations and Commissioning. However, the team observed that the interface between Operations and Commissioning is not always adequate to ensure proper control and oversight by the control room operators of operating activities related to handed-over systems that are in progress. The team made a suggestion in this area.

13.2 ORGANIZATION AND MANAGEMENT OF COMMISSIONING

The plant has developed a complex fire safety programme to ensure fire safety both in construction and operational areas. However, the team noted that fire scenarios that are supposed to be used by the external fire brigade have not yet been tested or approved for use in the most hazardous fire areas. Arrangements for the evaluation of fire loads do not take into consideration the total fire load inside the compartment and fire suppression systems' capacity. Compensatory measures are not always in place in areas where fire protection features important for safety are not yet fully operational. Multiple cases of deviations from fire protection requirements were noted in the field. The plant should improve the arrangements and practices targeting the integrity of fire barriers and prompt fire suppression to ensure that fire risk is always minimized. The team made a recommendation in this area.

The station has put some arrangements in place to keep the serenity in the Main Control Room (MCR) by implementing an additional guard outside the entrance. However, the team observed that the arrangements in place during the commissioning period, was not always adequate to ensure the control room serenity during conduct of operating activities. On several occasions, people were entering the MCR without asking for permission. The team encouraged the plant to improve in this area.

13.3. IMPLEMENTATION OF THE COMMISSIONING PROGRAMME

The plant has a large amount of open modifications, emergent work activities, open deviations, and rework that has challenged the ability to safely manage remaining work. Interviews with members of the plant staff indicated that they have little confidence in the schedule and often only look 1-2 weeks ahead. Contributing to these delays is rework required due to inadequate verification of quality during and after work performance. This includes verification of the physical installation and verification of documentation. The team made a suggestion in this area.

The plant uses a proactive approach to demonstrate regulatory compliance prior to startup. The DPN (Operating Organization) accomplishes this in a methodical and comprehensive manner. Each regulatory requirement is identified in a database and validated. Approximately 10,000 requirements were extracted from French law for environmental protection matters alone. If compliance has not been achieved, follow-up actions are systematically tracked. The team identified this as a good performance.

DETAILED COMMISSIONING FINDINGS

13.1. THE COMMISSIONING PROCESS

13.1(1) Issue: The interface between Operations and Commissioning does not always ensure proper control and oversight by the control room operators of safety related activities in progress on handed-over systems.

The team noted the following**:**

- When performing commissioning tests that could affect systems already handed over to the station, the last barrier to prevent manipulations of faulty components, is the Lead Operator (LO) in the Main Control Room (MCR). When tests are performed in the MCR, the Test Leader (TL) is supposed to inform the LO before starting the test. However, there is no clear process on what the LO should control or what documentation is to be used to avoid tests being performed on faulty equipment. According to an MCR operator an Excel spreadsheet being used for this purpose was not fully reliable because information could be missing due to late up-dating and the database being used could show a system as handed over even though it was only partly handed over.
- During commissioning tests there is no expectation for test leaders to inform the MCR Operators before starting the test, unless it might affect other systems already handed over. Moreover, on these occasions there is no requirement for Peer Check by a licensed Operator.
- In the MCR, the audible alarm from the fire detection panel was reduced to a hardly hearable level. Only when standing approximately 1 meter away was it possible to hear the alarm. The reason given was to reduce the disturbance for the Operators, and the adjustment was made by the contract worker in charge of the fire detection panel.
- There is no formalised Pre-Job Brief or Post Job Debrief between Commissioning and Operations, when performing a test that could affect already handed over systems. As a result, changes could be made that affect handed over systems yet not known to the operators. In addition, if changes are made to the systems, this could affect the validity of the temporary procedure.
- In the MCR, the contract worker in charge of the fire detection system, left his position without handing over the responsibility (contrary to station expectations) and went to the reactor building. While absent, an alarm appeared, which was detected by an Operator in the MCR. The Operator tried to contact the responsible person and the Fire Coordinator. Neither of these could be contacted. To mitigate this, the Operator sent a Field Operator to verify if the fire was real.
- A Temporary procedure (2019 00025) to be used during a gaseous filling had a hand amendment which had no signature or traceability of the origin. This deviation was not noted by the shift crew during the Pre-Job Brief.
- The operations team together with commissioning team defines the boundaries to be tagged out for the test work permits. However, the tagging office doesn't have a commissioning procedure for the system and consequently does not have the full information on what is planned to do. Example: operations staff do not know where the water after flushing will be discharged to.

- The temporary operating procedure for the stator cooling system (GST) refers to the use of alarm sheets in hard copy in MCR in case of alarms. These alarm sheets have not been found in the designated folder in the MCR.

Lack of an effective interface between Operations and Commissioning, could hamper the control and oversight by the control room operators of activities related to handed-over systems that are in progress.

Suggestion: The plant should consider enhancing the interface between Operations and Commission groups to ensure proper control and oversight by the control room operators of safety related activities in progress on handed-over systems.

IAEA Bases:

SSR-2/2 (Rev.1)

6.12. The operating organization shall ensure that the interfaces and the communication lines between different groups (i.e. groups for design, groups for construction, contractors, groups for commissioning and groups for operations) shall be clearly specified and controlled.

SSG-28

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

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

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

3.39. Appropriate work control processes should be established to coordinate the activities of all groups involved in commissioning and to cover the major work activities, including post-work testing. These processes should provide for the proper channeling of the work to the persons responsible for the systems and for ensuring notification and awareness by the control room operators of all the work activities that are in progress.

13.2. ORGANIZATION AND MANAGEMENT OF COMMISSIONING

13.2(1) Issue: The plant arrangements and practices to protect the integrity of fire barriers and ensure effective fire suppression have not been fully developed and implemented to minimise fire risk.

The team noted the following:

- The plant has developed fire response sheets for the plant fire team for the individual fire compartments inside buildings handed over to operations, but the external fire brigade uses ‘fire scenarios’ which cover the most hazardous buildings. Out of 19 scenarios needed only one was approved for use (for transformers). For other areas including those already handed over to operations (such as diesel generator building) the prototypes of scenarios had been developed but have not yet been tested and approved for use.
- The plant has no procedure in place to define which compensatory measures should be taken when fire hazards (such as unavailability of fire protection systems) are identified.
- In construction and commissioning areas:
    - The fire detection and fire suppression systems in operation do not cover all plant areas because construction and commissioning are incomplete. There is no requirement to have a fire suppression system in operation before putting fire loads in place (cables into cable trays, oil, diesel fuel etc.). No specific compensatory measures to ensure effective fire detection and extinguishing are in place (except those which are prescribed by the testing procedures).
    - The plant has no requirements to perform a quantitative risk analysis prior to introduction of fire loads into the construction and commissioning areas.
    - The plant has no requirement to perform periodic assessments of the cumulative effect of fire safety deviations (such as open fire doors or unsealed penetrations in fire compartment barriers) in construction and commissioning areas.
    - Fire response sheets are not in place to aid fire teams in the construction and commissioning areas.
    - There was a localized ignition event during the train 4 diesel generator 3LHS7101GE test on 27 June 2018, the test procedure does not prescribe the requirement to check readiness of the fire water spray system (i.e. pressure in the pipeline) or the actions required in the event of fire. The test procedure requirement to have fire protection systems ‘operational’ is ambiguous as it is not clear if these must be in automatic or manual modes or if they should already be handed over to operations.
    - Cable penetrations in fire protection barrier (walls) in multiple locations inside the safety systems building are not sealed.
    - Fire suppression system pipelines were observed with no handle on the water supply valves.
    - Temporary communications (cables, ventilation hoses) are routed through open fire protection doors in several locations in the safety systems building.

  - A fire extinguisher was absent from its designated place in the safety systems building.
  - The manual fire alarm actuator 3JDT3449AUJ3047 in the safety systems building is broken.
  - Fire barrier bags blocking cable penetrations were not positioned correctly for fire protection in the effluent treatment building (room HQ3 1775).
  - There was a combustible load without extinguisher in the effluent treatment building (room HQ3 1777).
  - One of the fire extinguishers in the safety systems building had not been checked between August 2017 and June 2019.
- In handed over to operations areas:
  - The approved version of the fire safety analysis is not available at the plant. The procedure allows authorization of the storage of transient combustibles without additional risk assessment if the fire load does not exceed 400 MJ/m2 (except for highly inflammable materials). The total fire load inside the compartment and fire suppression systems' capacity are not taken into consideration.
  - While there is no nuclear fuel at the plant there is no requirement in place to set priorities and time limits to fix fire barrier defects. A defect in the pumping station related to an unsealed cable penetration that connected rooms related to the different safety trains was not fixed for 92 days.

Without fully developed and implemented arrangements and practices to protect the integrity of fire barriers and ensure effective fire suppression the safety of personnel and equipment can be jeopardized.

Recommendation: The plant should improve the arrangements and practices that protect the integrity of fire barriers and ensure effective fire suppression to ensure the safety of personnel and equipment.

IAEA Bases:

SSR-2/2 (Rev.1)

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

NS-G-2.1

2.12. Procedures should be established for the purpose of ensuring that amounts of combustible materials (the fire load) and the numbers of ignition sources be minimized in areas containing items important to safety and in adjacent areas that may present a risk of exposure to fire for items important to safety.

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

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

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

6.4. The use of combustible materials in the furnishings of the power plant should be minimized. Combustible materials should not be used for decorative or other non-essential effect in areas identified as important to safety.

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

7.3. Minimum acceptable levels of availability should be established and documented for all fire protection features identified as important to safety. Interim compensatory measures should be defined for each fire protection feature identified in this way. These compensatory measures should be implemented on a temporary basis in the event that the minimum level of availability for a given fire protection feature is not maintained or the fire protection feature is determined to be inoperable. Both the compensatory measure to be implemented and the allowable time schedule for its implementation should be determined, documented and reviewed. If the minimum acceptable level of availability of a fire protection measure has not been specified, it should be assumed to be 100%.

SSG-28

3.33. The responsibilities of the commissioning group should include, but are not limited to, the following:

– To ensure that the commissioning procedures comply with the appropriate rules and regulations, and requirements for safety (including those for radiation protection, nuclear safety, fire safety, industrial safety and protection of the environment);

3.47. Personnel should adhere to normal operating rules such as those relating to access to the control room, access to control cabinets and switchboards, control of information, communication with the control room about abnormalities and changes to plant configuration.

4.28. In determining the sequence of testing, the following four points should be considered:

(ii) Certain specific support systems (e.g. compressed air system, electrical system, service water system, system for supply of demineralized water, system for the management of radioactive waste, ventilation system, drainage system) should be commissioned prior to other systems so that they are available for the testing of other systems.

(iii) Certain specific systems should be operational to ensure that other systems can be tested without jeopardizing personnel, the plant or nuclear safety (e.g. fire protection systems, radiation protection systems, emergency power system, system for the management of radioactive waste).

4.31. In a satisfactory pre-operational test, the proper sequence of tests of electrical systems, instrumentation systems and other service systems such as cooling water systems and fire protection systems should be taken into account to ensure the availability of the necessary services for the entire commissioning programme.

SSG-38

2.15. Necessary fire protection measures at the construction site should remain available until the fire detection, protection and suppression systems for the installation are operational. Details of these measures should be included in the arrangements for emergency preparedness and response.

5.35. Storage areas should be established with account taken of aspects such as:

(a) Cleanness and housekeeping practices;

(b) Requirements for fire protection;

(c) Protective requirements relating to coatings, preservatives, covers and sleeves;

(d) Prevention of physical damage;

13.3. IMPLEMENTATION OF THE COMMISSIONING PROGRAMME

13.3(1) Issue: The large number of open modifications, emergent work activities, open deviations, and rework are not always adequately managed to minimize the potential impact on safety and quality.

The team noted the following:

- Inappropriate control of contractors and verification of their documentation has resulted in some errors and affected implementation of the project. These have occurred in different phases of the construction and commissioning process.
- Management of non-conformances and deviations is not always rigorous:
  - Non-conformance report related to deviations of the SBO Diesel Generator (in the construction phase) was initiated two years after the deviation occurred.
  - Testing identified non-conformances in some welds. As a result, construction was interrupted, and an extensive action plan launched. However, the committee for characterizing deviations, did not conduct a timely assessment of the full extent of the issue.
  - The multifunctional group that evaluates all deviations and non-conformances from commissioning and construction only meets on a monthly basis which may be insufficient to ensure progress is made and challenges do not exist.
  - More than 10 databases are used to track deviations in the construction and commissioning phase making it difficult to a get clear picture of the level of work needed to be completed prior to handover. Four databases are used to track deviations after handover of systems and buildings from the AFA (Construction) to DPN (Operating) organization.
- There is a large amount of work that must be completed to meet key milestones such as Phase 2 of Hot Functional Testing and Fuel Loading. For example:
  - For Hot Functional Test Phase 2:
    - 140 modifications have been installed but not yet contractually verified in the field;
    - 100 modifications are in progress;
    - As of June, 26 2019, 476 commissioning tests are in progress and need to be finalized;
    - 212 deviations need to be resolved, about 100 of these are considered significant.
  - For fuel loading:
    - 300 modifications have been installed but not contractually verified on the field;
    - 1000 modifications are in progress;
    - As of 26 June 2019, 8437 activities from the ‘tracking databases for balance of work’ need to be completed.

– An integrated resource loaded schedule has deliberately not been developed by the Project for remaining work, though this schedule exists on a craft by craft basis. Interviews with Operations Staff members indicated that they are typically able to look ahead two weeks. Interviews with other members of the plant staff indicated that schedules are not routinely updated.

– The CES (Field Test Commission) is responsible for checking that the objectives set by the start-up test programme have been achieved and enabling the next phase to get underway. The CES serves as the final barrier of validation and its effectiveness can be challenged when there is many open work activities and deviations that must be reviewed to determine whether commissioning activities can proceed.

– The installed quality assurance during and after performed works is not always capable to guarantee component's or equipment's faultless installation and repair. The following are some examples of issues identified by the OSART Team during plant walkdowns and not recorded in plant databases:

  – Grounding is not connected to the cable tray with cables in the medium pressure safety injection pump 3RIS4420PO room.

  – Damaged insulation casing on the Safety Injection System. Damaged insulation was found on RIS 2510 TY-F05/P4A and RIS 2510 TY F05/P3A, and on valve RIS2292.

  – Connections of the grounding cable for the safety injection pump 3RIS4420POM motor are painted.

  – Several scotch tape rolls were found used in reactor and turbine building without being marked with PMUC (safe to use). Use of tape with unknown substances in the glue can cause chlorine induce corrosion on safety related stainless steel components.

If the large number of open modifications, emergent work activities, open deviations, and rework are not adequately managed, the potential exists to impact safety and quality.

Suggestion: The Commissioning and Operating organizations should consider enhancements to the oversight and verification of remaining work activities to ensure safety and quality.

IAEA Bases:

GSR Part 4

4.6 A safety assessment shall be carried out at the design stage for a new facility or activity, or as early as possible in the lifetime of an existing facility or activity. For facilities and activities that continue over long periods of time, the safety assessment shall be updated as necessary through the stages of the lifetime of the facility or activity, so as to take into account possible changes in circumstances (such as the application of new standards or new scientific and technological developments), changes in site characteristics, and modifications to the design or operation, and also the effects of ageing.

4.7. In the updating of the safety assessment, account also shall be taken of operating experience, including data on anticipated operational occurrences and accident conditions and accident precursors, both for the facility or the activity itself and for similar facilities or activities.

5.2. The safety assessment in itself cannot achieve safety. Safety can only be achieved if the input assumptions are valid, the derived limits and conditions are implemented and maintained, and the assessment reflects the facility or activity as it actually is at any point in time. Facilities and activities change and evolve over their lifetimes (e.g. through construction, commissioning, operation, and decommissioning and dismantling or closure) and with modifications, improvements and effects of ageing.

NS-G-2.3

4.8. An initial safety assessment should be carried out before starting a modification to determine whether the proposed modification has any consequences for safety and whether it is within the regulatory constraints for the plant design and operation. This initial assessment should be carried out by trained and qualified personnel, taking a systematic approach, and should be reviewed by an independent safety expert.

4.13. The scope, safety implications and consequences of proposed modifications should be reviewed by personnel not immediately involved in their design or implementation. These reviewers should include representatives of the operators and engineering personnel, the design organization, safety experts, and other technical or managerial advisers. The latter may also include independent external advisors, particularly for major modifications, as necessary to ensure that a full and adequately informed discussion of the modification, including all its safety implications for the plant, can be held. These reviews should also include independent validation and verification of software changes for major modifications.

SSG-28

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

3.67. The provision of a consistent process for the management of non-conformances is a requirement of all management systems. The process for the management of non-conformances should apply to the failure of components to meet their specified performance requirements and to the failure of larger systems to meet their requirements on the basis of the safety analysis or other performance specifications. A robust system for recording and resolving non-conformance and for approving concessions, corrective actions and preventive actions should be in place.

5.7. The purpose of the commissioning manual is to specify the organizational structure and responsibilities for the management and control of testing and commissioning, to meet the requirements for quality, established requirements, statutory obligations and the licence provisions. The commissioning manual should specify the extent and nature of, and the approval process for, the documentation, including procedures and certificates to be used during commissioning.

DEFINITIONS

DEFINITIONS – OSART MISSION

Recommendation

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

Suggestion

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

Good practice

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

LIST OF IAEA REFERENCES (BASIS)

Safety Fundamentals

SF-1	Fundamental Safety Principles (Safety Fundamentals)

General Safety Requirements

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 7	Preparedness and Response for a Nuclear or Radiological Emergency

Specific Safety Requirements

SSR-2/1 (Rev. 1)	Safety of Nuclear Power Plants: Design
SSR-2/2 (Rev. 1)	Safety of Nuclear Power Plants: Commissioning and Operation
SSR-5	Disposal of Radioactive Waste

General Safety Guides

GSG-1	Classification of Radioactive Waste
GSG-2	Criteria for Use in Preparedness and Response for a Nuclear and Radiological Emergency

Safety Guides

NS-G-1.1	Software for Computer Based Systems Important to Safety in Nuclear Power Plants
NS-G-2.1	Fire Safety in the Operation of Nuclear Power Plans
NS-G-2.2	Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants
NS-G-2.3	Modifications to Nuclear Power Plants

NS-G-2.4	The Operating Organization for Nuclear Power Plants
NS-G-2.5	Core Management and Fuel Handling for Nuclear Power Plants
NS-G-2.6	Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants
NS-G-2.8	Recruitment, Qualification and Training of Personnel for Nuclear Power Plants
NS-G-2.13	Evaluation of Seismic Safety for Existing Nuclear Installations
NS-G-2.14	Conduct of Operations at Nuclear Power Plants
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
GS-G-4.1	Format and Content of the Safety Analysis report for Nuclear Power Plants
RS-G-1.8	Environmental and Source Monitoring for Purposes of Radiation Protection
WS-G-6.1	Storage of Radioactive Waste
WS-G-2.5	Predisposal Management of Low and Intermediate Level Radioactive Waste

Specific Safety Guides

SSG-2	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-50	Operating Experience Feedback for Nuclear Installations
SSG-54	Accident Management Programmes for Nuclear Power Plants

INSAG publications

INSAG-4	Safety Culture
INSAG-10	Defence in Depth in Nuclear Safety
INSAG-12	Basic Safety Principles for Nuclear Power Plants, 75-INSAG-3 (Rev. 1)
INSAG-13	Management of Operational Safety in Nuclear Power Plants
INSAG-14	Safe Management of the Operating Lifetimes of Nuclear Power Plants
INSAG-15	Key Practical Issues In Strengthening Safety Culture
INSAG-16	Maintaining Knowledge, Training and Infrastructure for Research and Development in Nuclear Safety
INSAG-17	Independence in Regulatory Decision Making
INSAG-18	Managing Change in the Nuclear Industry: The Effects on Safety
INSAG-19	Maintaining the Design Integrity of Nuclear Installations throughout their Operating Life
INSAG-20	Stakeholder Involvement in Nuclear Issues
INSAG-23	Improving the International System for Operating Experience Feedback
INSAG-25	A Framework for an Integrated Risk Informed Decision-Making Process

Safety Report Series

SRS No.11	Developing Safety Culture in Nuclear Activities Practical Suggestions to Assist Progress
SRS No.21	Optimization of Radiation Protection in the Control of Occupational Exposure
SRS No.48	Development and Review of Plant Specific Emergency Operating Procedures
SRS No. 57	Safe Long-Term Operation of Nuclear Power Plants

Other IAEA Publications

Safety Glossary	Terminology used in nuclear safety and radiation protection 2016 Edition
Services Series No.12	OSART Guidelines 2015 Edition

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

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

EPR-EXERCISE-2005 Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency

EPR-NPP PPA 2013 Actions to Protect the Public in an Emergency due to Severe Conditions at a Light Water Reactor

International Labour Office publications on industrial safety

ILO-OSH 2001 Guidelines on occupational safety and health management systems (ILO guideline)

Safety and health in construction (ILO code of practice)

Safety in the use of chemicals at work (ILO code of practice)

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