Operational
Safety Review
Team

IAEA OSART

REPORT

OF THE

OPERATIONAL SAFETY REVIEW TEAM

(OSART)

MISSION

TO THE

HEYSHAM 2
NUCLEAR POWER PLANT
UNITED KINGDOM

2 TO 19 OCTOBER 2023

DIVISION OF NUCLEAR INSTALLATION SAFETY
OPERATIONAL SAFETY REVIEW MISSION
IAEA-NSNI/OSART/220/2023

PREAMBLE

This report presents the results of the IAEA Operational Safety Review Team (OSART) review of Heysham 2 Nuclear Power Plant, United Kingdom. It includes recommendations and suggestions for improvements affecting operational safety for consideration by the responsible United Kingdom 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 United Kingdom organizations is solely their responsibility.

FOREWORD
By the Director General

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

An OSART mission, carried out only at the request of the relevant Member State, is directed towards a review of items essential to operational safety. The mission can be tailored to the particular needs of a plant. A full scope review would cover ten operational areas: Leadership and Management for Safety; Training and Qualification; Operations; Maintenance; Technical Support; Operating Experience Feedback; Radiation Protection; Chemistry; Emergency Preparedness and Response, and Accident Management. Depending on individual needs, the OSART review can be directed to a few areas of special interest or cover the full range of review topics.

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

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

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

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

EXECUTIVE SUMMARY

This report describes the results of the OSART mission conducted for Heysham 2 Nuclear Power Plant (NPP), United Kingdom from 2 to 19 October 2023.

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

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

The mission was coordinated by an IAEA Team Leader and Deputy Team Leader and the team was composed of experts from Brazil, Canada, Finland, France, Germany, Slovakia, Sweden, USA, and IAEA staff members. The collective nuclear power experience of the team was approximately 354 years.

The team identified 19 issues, eight of these are recommendations, and 11 of these are suggestions. Nine good practices were also identified.

Several areas of good practice were noted:

- The plant has implemented a system called “wall hound” to detect electromagnetic interference and radio frequency interference (EMI/RFI) emitted by mobile phones, laptops and smart watches raising an audible and visual cue/prompt.
- The use of hot connection indicators by the plant to monitor cable connections temperature.
- The use of chemistry preservation metric by the plant to monitor system status.

The most significant proposals for improvements identified were:

- The plant should improve its approach in setting and reinforcing expectations and challenge the site personnel to identify and correct substandard conditions and equipment deficiencies in a timely manner.
- The plant should improve the material condition of some plant systems, structures, and components to further reduce the risk to plant safety and reliability.
- The plant should improve the control of fire doors and storage in the plant to further reduce fire risk to equipment and personnel safety.

Heysham 2 NPP management expressed their commitment to address the issues identified and invited a follow up visit in about eighteen months to review the progress.

CONTENT

INTRODUCTION AND MAIN CONCLUSIONS

INTRODUCTION

At the request of the government of the United Kingdom, an IAEA Operational Safety Review Team (OSART) of international experts visited Heysham 2 Nuclear Power Plant from 2 to 19 October 2023. The purpose of the mission was to review operating practices in the areas of Leadership and Management for Safety, Training and Qualification, Operations, Maintenance, Technical Support, Operating Experience Feedback, Radiation Protection, Chemistry, Emergency Preparedness & Response, and Accident Management. In addition, an exchange of technical experience and knowledge took place between the experts and their plant counterparts on how the common goal of excellence in operational safety could be further pursued.

The Heysham 2 Nuclear Power Plant (NPP) OSART mission was the 220th in the OSART programme, which began in 1982. The team was composed of experts from Brazil, Canada, Finland, France, Germany, Slovakia, Sweden, USA, and three IAEA staff members. The collective nuclear power experience of the team was 354 years.

Before visiting the plant, the team studied information provided by the IAEA and the Heysham 2 NPP to familiarize themselves with the plant's main features and operating performance, staff organization and responsibilities, and important programmes and procedures. During the mission, the team reviewed many of the plant's programmes and procedures in depth, examined indicators of the plant's performance, observed work in progress, and held in-depth discussions with plant personnel.

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

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

MAIN CONCLUSIONS

The OSART team concluded that the managers of the Heysham 2 NPP are committed to improving the operational safety and reliability of their plant.

The team found areas of good practice, including the following:

- The plant has implemented a system called “wall hound” to detect electromagnetic interference and radio frequency interference (EMI/RFI) emitted by mobile phones, laptops and smart watches raising an audible and visual cue/prompt.
- The use of hot connection indicators by the plant to monitor cable connections temperature.
- The use of chemistry preservation metric by the plant to monitor system status.

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

- The plant should improve its approach in setting and reinforcing expectations and challenge the site personnel to identify and correct substandard conditions and equipment deficiencies in a timely manner.
- The plant should improve the material conditions of some plant systems, structures, and components to further reduce the risk to plant safety and reliability.
- The plant should improve the control of fire doors and storage in the plant to further reduce fire risk to equipment and personnel safety.

Heysham 2 NPP management expressed their commitment to address the issues identified and invited a follow up visit in about eighteen months to review the progress.

1. LEADERSHIP AND MANAGEMENT FOR SAFETY

1.1. LEADERSHIP FOR SAFETY

The team identified that managers and supervisors are not always effectively setting and reinforcing expectations and challenging plant personnel to identify and correct substandard conditions and equipment deficiencies in a timely manner to drive continuous safety performance improvement. For example: during the review the team observed the following, field operators were not systematically identifying and reporting all deficiencies, additional equipment/materials were left at work sites, without proper fire loading risk assessments, the need for a number of maintenance tasks to be reworked, material deficiencies open for long time periods due to large work backlogs, oil leaks on all diesel generators, unsecured items in seismically controlled areas, contamination and occupational exposure control shortfalls. The team made a recommendation in this area.

To complement the corporate leadership programme, the plant took several specific initiatives to support leadership development. Firstly, the plant took the initiative to support individuals interested in progressing into future leadership positions. This approach is being replicated at two other plants within the fleet. Secondly, professional actors creating realistic scenarios are used to support the Leadership Development Programme that provides key interventions including Performance Management, Meeting Effectiveness and Intrusive Leadership. All the leaders surveyed following the training said that the content was relevant. Thirdly, the plant uses a Personality Preferences Profile Programme with leaders to explore how they operate as part of a leadership team. This approach uses a simple four-colour model to help people understand their style, strengths and the value they bring to the team. This was rolled out to the executive team and several department lead teams. The team identified this as a good performance.

1.3. SAFETY CULTURE

The team did not undertake a detailed safety culture assessment at the plant. However, the collective experience of the team was used to capture safety culture attributes, behaviours and practices which help to shape and define the safety culture at the plant. With respect to the observed strength, the team identified that the plant has a good reporting culture enabled by a respectful work environment. The operating experience (OPEX) is well embedded and communicated: morning briefs involve all plant personnel and are customized if needed, the use of event briefs in pre-job briefs is relevant. In addition, the decision-making is rigorous and a conservative approach has been clearly demonstrated.

In contrast, the plant’s overall performance had been challenged in recent years by the change to off-load depressurized refuelling. In addition, the plant personnel turnover is bringing new challenges with respect to staff experience and coaching needs. Individual’s risk perception, compliance with rules and questioning attitude towards equipment deficiencies needs additional leadership focus. Deficiencies are not always promptly identified, fully evaluated, addressed and corrected in a timely manner. In some cases, deficiency backlogs are impacting equipment reliability. Maintenance rework and changes to the work cycle are bringing additional complexity in work planning and execution.

1.5. HUMAN FACTORS MANAGEMENT

The plant has implemented a system called “wall hound” to detect electromagnetic interference and radio frequency interference (EMI/RFI) emitted by mobile phones, laptops and smart watches by raising an audible and visual cue. The device is in 3 key locations of the plant: the entrance to the Radiological Controlled Area (RCA), the reactor building, and the entrance to the safety circuit/main control room. In 2023, the system detected about 300 devices per month with less than 2% found to be unauthorized for which subsequent actions were taken. The team identified this as a good practice.

1.6. NON-RADIATION-RELATED SAFETY PROGRAMME

The team identified that industrial safety hazards and unsafe behaviours are not always corrected to prevent personnel injuries. During the Unit 8 outage three injuries, two High Potential Events and five events associated with the process of plant isolation occurred in Operation and Maintenance groups. During observations of field activities in the plant, the team identified several unsafe conditions and inappropriate behaviours in the work being performed in the CO2 plant, the diesels generator rooms and a chemistry laboratory. The team made a recommendation in this area.

DETAILED LEADERSHIP AND MANAGEMENT FOR SAFETY FINDINGS

1.1.LEADERSHIP FOR SAFETY

1.1 (1) Issue: Managers and supervisors are not always effective at setting and reinforcing expectations and challenging plant personnel to identify and correct substandard conditions and equipment deficiencies in a timely manner to drive continuous safety performance improvement.

The plant's overall performance had been challenged in recent years by the change to off-load depressurized refuelling. The plant is taking improvement actions recognising it has had high staff turnover and a number of industrial safety events and near misses. However, the team noted the following:

- During the review the team identified gaps in several areas such as industrial safety, fire safety, operations practices, conduct of maintenance, seismic control and radiological protection:
  - The team observed industrial safety hazards and unsafe behaviours not always being corrected.
  - Some gaps were identified with field operators not systematically identifying and reporting deficiencies during shift rounds.
  - The team observed unauthorized fire loads not being promptly removed in some areas of the plant and most notably in requiring a fire watch.
  - Gaps were observed in maintenance conduct leading in some cases to rework and material deficiencies impacting equipment reliability.
  - Gaps in seismic control where loose or unsecured items were observed in seismically controlled areas in plant.
  - In the radiological protection area, shortfalls were observed related to contamination control including boundaries and behaviours.
- During plant field visits, many leaks and material condition deficiencies were observed by the team both in radiological controlled areas (RCA) and non-RCA areas for safety-important equipment such as gas circulators, emergency diesel generators, cooling water pumps, and turbine generators. These were not identified by the plant staff, and most were in accessible areas that are frequently visited by walkdowns and shift rounds.
- On week 40 in 2023, the total non-outage defects and outage defect backlogs for both units were 434 and 368. In addition, the backlog of lower level deficiencies to be implemented within appropriate maintenance windows and/or use as fill in work when resources allow was 2455.
- On 26 September 2023 the DX Diesel Generator was started for a Maintenance Schedule (MS) test run and had to be subsequently shut down due to excessive smoke. On a second test run oil leaks were evident and due to the heat of the engine some of the leaking oil combusted creating a small flame, which quickly self-extinguished. The DX diesel generator was shutdown and subsequently declared unavailable for three days. The plant indicated that there had been one similar event in the past.
- The last outage was extended by four days due to an oil leak which contained some hydrogen resulting from inappropriate maintenance by a Specialist Turbine Maintenance Group. The same group improperly tightened a pilgrim bolt during the previous statutory outage on Unit 8 in 2020 leading to a four week forced shut down of the unit early 2023.
- On 6 June 2020, the BY diesel generator was documented to have excessive standing oil, with an indeterminate leaking component. The associated condition report suggested

“Routine cleaning is failing to maintain an acceptable standard in this diesel house” and stated “The work planned for the leak repair is over two years away – this is not acceptable.” The cross-referenced work order for leak repair was originally scheduled for July 2022, however cancelled on 10 June 2022 when the leakage could not be identified during a test run. Subsequently, a work request was generated on 21 February 2023 when the leak reappeared. This work is scheduled during a BY diesel outage in 2024.
- Plant Surveys, Interviews from with managers, Nuclear Operation Support Team and Independent Nuclear Assurance (INA) have identified challenges to aligning workforce behaviours to expectations and the appropriate standards.

Without having managers and supervisors effectively setting and reinforcing expectations and challenging the site personnel to identify and correct substandard conditions and equipment deficiencies in a timely manner the plant operational safety performance could be challenged.

Recommendation: The plant should improve its approach in setting and reinforcing expectations and challenge the site personnel to identify and correct substandard conditions and equipment deficiencies in a timely manner.

IAEA Bases:

SSR-2/2 (Rev.1)

4.2. The safety policy shall stipulate clearly the leadership role of the highest level of management in safety matters. Senior management shall communicate the provisions of the safety policy throughout the organization. Safety performance standards shall be developed for all operational activities and shall be applied by all site personnel. All personnel in the organization shall be made aware of the safety policy and of their responsibilities for ensuring safety. The safety performance standards and the expectations of the management for safety performance shall be clearly communicated to all personnel, and it shall be ensured that they are understood by all those involved in their implementation.

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

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

3.2. Managers at all levels in the organization, taking into account their duties, shall ensure that their leadership includes:
(a) Setting goals for safety that are consistent with the organization’s policy for safety, actively seeking information on safety performance within their area of responsibility and demonstrating commitment to improving safety performance;
(b) Development of individual and institutional values and expectations for safety throughout the organization by means of their decisions, statements and actions;

(c) Ensuring that their actions serve to encourage the reporting of safety related problems, to develop questioning and learning attitudes, and to correct acts or conditions that are adverse to safety.

3.3. Managers at all levels in the organization:
(a) Shall encourage and support all individuals in achieving safety goals and performing their tasks safely;
(b) Shall engage all individuals in enhancing safety performance;

4.36. 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.

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.

1.5. HUMAN FACTORS MANAGEMENT

1.5 (a) Good practice: The plant has implemented a system called “wall hound” to detect electromagnetic interference and radio frequency interference (EMI/RFI) emitted by mobile phones, laptops and smart watches raising an audible and visual cue/prompt.

The device detects EMI/RFI (including Bluetooth) emissions from devices such as mobile phones, laptops, smart watches. The EMI/RFI system that works alongside the detectors logs all Media Access Control Addresses of devices detected. These are reviewed periodically.

If detected within the range (typically 0.3 - 5m) it gives an audible and visual cue. The sign lights up in red and plays an audible warning: “Mobile device detected”.

The plant has a set of personal key-less lockers nearby to store any devices if they are not removed prior to entry into the Radiation Control Area (RCA). The device can then be collected on the way back out of the RCA (or sensitive plant area).

The Wall Hound System was installed in 2020. The device is in 3 key locations on site: the entrance to the RCA, the reactor building, and in the safety circuit/main control room. Certain devices are authorized for use by the plant staff and provisions are established to determine whether detected items are allowed or prohibited.

When initially implemented, the system detected about 450 devices per month. In 2023, the system is detecting about 300 devices per month and about 5 devices per month were found to be unauthorized and required action to be taken.

The benefit of the Wall Hound System is the prompt detection of EMI/RFI which could impact sensitive plant equipment and possibly impair equipment function resulting in a transient or plant trip.

Figure 1.1: Picture of a Wall hound device

1.6.NON-RADIATION-RELATED SAFETY PROGRAMME

1.6 (1) Issue: Industrial safety hazards and substandard behaviours are not always effectively identified and corrected to help prevent personal injuries.

The team noted the following:

- The Total Recordable Injury Rate at the plant is 1.6 and the Industrial Safety and Focus Index (ISFI) composite and 3 months rolling index is showing red at the end of September 2023.
- Three injuries involving contractors were recorded during the last Unit 8 statutory outage.
- Two High Potential Events were reported during the last outage: a container weighing about 175kg fell from the forks of a forklift truck; during a lifting operation on the primary coolant bypass gas plant a cover weighing 4.7 kg failed and fell from height of 6 meter landing near workers.
- Five level 1 safety rule events associated with the process of plant isolation across both Maintenance and Operations occurred over six weeks at the end of the second quarter of 2023:
  - A vent valve was replaced on the Make Up Water Treatment Plant without the working party being signed onto the safety document to allow work to be carried out.
  - The General Provision (GP) #3 procedure was not followed during an open hole work on the pile cap. The control room desk engineer was not informed that a hole was to be made in the reactor vessel, by removal of a plug-unit, although it was requested by the GP3 procedure in order to prevent contamination spread.
  - A gas circulator test run was started without collecting the safety document.
  - During the release of a bung on a re-heater penetration during outage work, an unexpected pressure was discharged causing the ejection of the bung.
  - A drum screen anti-rotation device was damaged by the movement of the drum screen. The anti-rotation device was damaged whilst enacting work due to poor communications between team members.
- The OSART team identified during the plant tour several unsafe conditions and inappropriate behaviours such as:
  - A CO2 in air monitoring was out of order in the CO2 plant with insufficient mitigation put in place. The CO2 warning sign put as mitigation did not state the need for the use of separate Gas Monitoring Instrument (GMI) which would have been the appropriate mitigation measure.
  - In the conventional laboratory, five workers were observed without light eye protection although the laboratory is recognised by chemistry staff as a “light eye protection” area. The PPE safety requirements for wearing eye protection in this area are not clearly specified.

Without effectively addressing industrial safety hazards and correcting unsafe practices and behaviours, the likelihood of personnel injuries may increase.

Recommendation: The plant should effectively identify and address industrial safety hazards and correct substandard behaviours to help prevent personnel injuries.

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.

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

GS-G-3.5

5.73. A process that reflects the national industrial safety regulations should be established for all individuals, suppliers and visitors, and the process should refer to the rules and practices for industrial safety that are to be adopted. The process should include arrangements for the effective planning, organization, monitoring and review of the preventive and protective measures for industrial safety.

ILO-OSH 2001

3.10.1. Prevention and control measures
3.10.1.1. Hazards and risks to workers' safety and health should be identified and assessed on an ongoing basis. Preventive and protective measures should be implemented in the following order of priority:
(a) eliminate the hazard/risk;
(b) control the hazard/risk at source, through the use of engineering controls or organizational measures;
(c) minimize the hazard/risk by the design of safe work systems, which include administrative control measures; and
(d) where residual hazards/risks cannot be controlled by collective measures, the employer should provide appropriate personal protective equipment, including clothing, at no cost, and should implement measures to ensure its use and maintenance.

3.10.1.2. Hazard prevention and control procedures or arrangements should be established and should:
(a) be adapted to the hazards and risks encountered by the organization;
(b) be reviewed and modified if necessary on a regular basis;
(c) comply with national laws and regulations, and reflect good practice; and
(d) consider the current state of knowledge, including information or reports from organizations, such as labour inspectorates, occupational safety and health services, and other services as appropriate.

2. TRAINING AND QUALIFICATIONS

2.1 ORGANIZATION AND FUNCTIONS

Training has begun to involve members of the Royal Air Force (RAF) to provide simulator observations and feedback. This feedback focuses largely on developing non-technical skills, such as communication, leadership and decision making. This framework, initially used in the aviation industry, is equally applicable to the nuclear industry, especially as it relates to stressful or emergent situations. The military training expertise and experience is used to reinforce teamwork behaviours and staying in role in an environment characterized by stress, ambiguity, time pressure and significant consequences for an error. As a result, this benefits operating crew's teamwork effectiveness during emergency situations. The team identified this as a good practice.

2.2 TRAINING FACILITIES AND MATERIAL

The plant adopted an effective method to use Closed Circuit Television (CCTV) in maintenance mock-up training facilities to improve evaluation and feedback from the training. CCTV cameras are installed in the maintenance mock-up training area, whereby Maintenance personnel (Leaders and Peers) observe via remote video and then provide coaching feedback and performance evaluation with the support of the instructors. The team recognized this as a good performance.

DETAILED TRAINING AND QUALIFICATION FINDINGS

2.1. ORGANIZATION AND FUNCTIONS

2.1 (a) Good practice: The plant has used military training expertise to develop high quality Crew Resource Management training.

After the plant identified 'Crew Resource Management' as an area requiring improvement, Training began to involve members of the Royal Air Force (RAF) to provide simulator observations and feedback. This feedback focused largely on developing non-technical skills, such as communication, leadership and decision making. This framework, initially used in the aviation industry, is equally applicable to the nuclear industry, especially as it relates to stressful or emergent situations.

The military training expertise and experience is used to reinforce teamwork behaviours and staying in role in an environment characterized by stress, ambiguity, time pressure and significant consequences for an error. As a result of the simulator observations and feedback from the RAF, individual performance diagrams are created for Duly Authorised Person (DAPs) to illustrate performance against the framework of Crew Resource Management. This information is then more widely used when looking at a shift teams' composition, enabling management to build the most compatible teams and improve overall performance.

As a result, this benefits operating crew's teamwork effectiveness during emergency situations.

Figure 2.1: Crew Resource Management

3. OPERATIONS

3.3 OPERATING RULES AND PROCEDURES

The team noted that a lack of clarity in some operating procedures had contributed to several recent operational events. The impact of lack of procedure clarity may be amplified by a large staff turnover where there is greater reliance on procedures over experience. The team encouraged the plant to enhance the clarity and periodic reviews of operating procedures.

3.4 CONDUCT OF OPERATIONS

The plant adopted a method of communicating contingency actions that may potentially be required to operating personnel across shift handovers. This works to identify the actions required in response to a fault that may develop while an abnormal equipment lineup is in effect, typically due to routine maintenance or an emergent issue. A contingency planning document is attached to the shift handover package and discussed between the Central Control Room Supervisor (CCRS) and the Unit Desk Engineer (UDE) at the start of shift. The team recognized this as a good practice.

The plant has installed Hot Connection Indicators over cables to give a warning of high temperature connections by changing colour, i.e., purple is normal temperature (OK), while pink indicates high temperature (Warning). These were installed as part of the lighting and small power inspection and testing programme. They allow a visual inspection without the need for monitoring equipment. The inspections can be carried out by any plant-based staff, to identify whether a previous overheating event has occurred and allow early signs of degradation to be identified outside of the planned routines. There had been numerous examples where hot connectors had changed colour, indicating early signs of degradation. These had been rectified in a timely manner before any medium or high-risk events occurred. The team recognized this as a good practice.

The team noted that although the field operators (FO) performed their prescribed plant parameter checks, their rounds are not always performed in a manner that ensures broader deficiencies in the field are effectively identified. Abnormal situations regarding seismic risks, water leaks or fire loading were not always identified by field operators conducting shift rounds. In addition, it was observed that an abnormal status alarm in a fire panel was not identified. The team made a suggestion in this area.

3.6. FIRE PROTECTION

The team observed that the plant does not always effectively control activities related to fire doors and fire loads in storage areas to ensure fire risks are minimized. The plant does not consistently through briefing or signage ensure that every worker is aware of the additional risks and expectations in an area subject to enhanced fire patrols. It was also observed that additional fire loads were present in several rooms without appropriate authorization. In addition, shortfalls were identified related to fire doors, including the expectations of manual closure or identifying defects. The team made a recommendation in this area.

3.7 CONTROL OF PLANT CONFIGURATION

The team noted that the plant had experienced several consequential configuration control events between 2020 and 2022. The plant has made improvements in the areas of safety-related and consequential plant misconfigurations. The team encouraged the plant to continue its effort to reduce low-level configuration control events.

DETAILED OPERATIONS FINDINGS

3.4. CONDUCT OF OPERATION

3.4 (a) Good Practice: Use of hot connection indicators to monitor cable connections temperature.

Hot connection indicators are installed in the plant over cables to give a warning of high temperature connections by changing colour, i.e., Purple is normal temperature (OK), Pink indicates high temperature (Warning).

Figure 3.1: Cable hot connection indicators

These were installed as part of the lighting and small power inspection and testing programme. They allow a visual inspection without the need for monitoring equipment. The inspections can be carried out by any plant-based staff, such as staff from Maintenance or Operations.

Once the connector has detected overheating, the colour change is permanent and does not revert to the normal temperature colour. This identifies whether a previous overheating event has occurred.

In addition to the routine lighting and small power inspections, the indicators allow early signs of degradation to be identified outside of the planned routines.

There have been numerous examples where hot connectors have changed colour, indicating early signs of degradation. These have been rectified in a timely manner before any medium or high-risk events occur.

This was communicated to all plant staff via a number of different communication routes. This has been shared within the fleet, and it is now documented in the Corporate technical guidance note for safety of fixed low voltage equipment and the electricity at work regulations.

3.4 (b) Good practice: Contingency plans during routine maintenance or emergent issues

During routine start of work authorization or in response to emergent equipment issues, the Central Control Room Supervisor (CCRS) generates contingency planning documentation. This documentation is transmitted in the shift handover package to align crews on the impact and response to any subsequent failures given the initial abnormal equipment lineup. These contingency plans do not replace approved alarm response procedures or Station Operating Instructions (SOI); however they are used to complement them and support Operations' knowledge, monitoring and control of plant conditions. The contingency plans are saved for posterity and able to be replicated during future work.

For example, an electrical fault SOI would govern the crew response and recovery from a loss of the power supply. The contingency documentation instead would outline the effects of the loss of the power supply, given the initial abnormal equipment lineup, and the compensatory measures to be undertaken. As part of the shift handover brief, the Central Control Room Supervisor (CCRS) discusses the contingencies in effect with the Unit Desk Engineer (UDE) to confirm an aligned understanding in the event of a fault.

These pre-written contingencies have been implemented over the years with improved Operations performance as a result. One example involved a failure of a gas circulator variable frequency converter during an outage period and restoration of cooling to that reactor quadrant.

R7 Contingency briefs	
Issue	Actions
TG7 EHG Duplex PLC	HYB/ROTA/0303 – Until the next R7 ODR, please review page 2 of the ROTA, it lists the valves that would not be in control should the 2nd PLC of the DUPLEX system fail. Envisaged immediate actions: - **First Action -** The plc failure will close the TG7-WC-244. The valve will need to be opened by taking the Air off and venting any residual Air within the valve actuator. - The DA will then start filling once the WC-244 is open and level can be controlled by the desk using the WC-342. - **Second Action -** The SS-202 will open admitting high pressure steam to the glands, the SS-210 will also close (this will over pressurise the glands). Slowly close in the SS-201. - Because the SA-201 and SS-207 will open, Aux steam will then be packing on. - All the spray water valves for the de-super heaters will be affected and the manual valves will need to be adjusted. - The SS-244 will close, causing BLAST to trip. This could cause a drop in pressure whilst the Aux boilers fire up and could result in the SA-75 closing.
7DY 110v Essential UPS	Replacement of 7DY 110v Essential UPS system including Battery, Battery Charger, Inverter, DC Distribution Cubicle, Static Bypass and Maintenance Bypass. See HYB/OPS/ORAF/0143 for Risk and Mitigations. Primary risk: Loss of AC supplies to 110v AC Ess UPS Board 7DY. This will cause loss of supplies to: Safety Thermocouple Marshalling Cubicle Channel 4 (LEH 7/958) causing control rods to trip to manual.
Station Tx 7	<file:\\G:\Operate\Shift Operations\Contingencies\Active contingencies - Unit 7\Station Transformer 7.doc>

R8 Contingency briefs	
Issue	Actions

Common Plant Contingency briefs	
Issue	Actions
CCR H&V	If PLC fails emergency recovery procedure is PIOI 3.40.25/140.
8 MCW Sealing flushing	Standby Pump currently running hot. S/By pump in service. In the first instance start the Main Pump as it has been ran for ~10 hours before a noticeable temperature increase. Contingency TOI HYB/TOI/1800 to enact whilst the Main pump is in service and monitored

Figure 3.2: Examples of Contingency Briefs

3.4 (1) Issue: The field operator rounds are not always performed in a manner that ensures deficiencies in the field are effectively identified.

The team noted that although the field operators performed their prescribed plant parameter checks, the following deficiencies were not identified:

- In 7A quadrant of the reactor building, a laydown area does not comply with plant standards. The fire load assessment was dated to December 2021 and later additional materials were added, such as four plastic flammable baskets, which were not on the list of assessed fire load. In addition, a mobile scaffold, which was not attached or immobilised, was placed at the edge of the area, and was close to some valves. The plant seismic expectation prohibits the storage of any mobile equipment in this area without appropriate restraint.
- In 7A quadrant of the reactor building, some status alarms were flashing on a fire panel (LHDC PANEL RE1). However, this was not identified by the Field Operator who conducted the field walkdown. When asked, the Operator did not know the reason for those alarms and explained that he does not check the fire panels as part of the routine tour he was conducting at the time.
- In the 7ABX Decay Heat Condensate Cooling Water (DHCCW) pump room, a mobile crane hoist was hanging in the room, and it was not secured to prevent inadvertent free movement. When asked, the Field Operator explained that this should have been removed after a previous maintenance activity.
- In the 7C quadrant of the reactor building, a sampling valve was leaking and drops were collected in a tundish with a drain. The tundish was 70% full and the outlet drain was blocked. The dripping speed was about 40 drops/min.
- In the decay heat plant room of the reactor building, when the Field Operator performed a lamp test on the main ventilation panel, he did not notice that one of the alarm lamps was defective.
- In the unit 7 bypass gas plant control room, a valve label had become detached from the plant and was found lying on the floor.
- In the unit 7 bypass gas plant control room, a mobile scaffold was standing close to the control panel with only one out of four brakes applied. The plant expectation is that mobile equipment should be suitably restrained to prevent interaction with installed equipment.

Without effectively identifying deficiencies in the field during field operator rounds, deficiencies will go uncorrected for longer than necessary, and the risk of fire, personnel injury and equipment damage could increase.

Suggestion: The plant should consider improving the field operator rounds to effectively identify and report deficiencies in a timely manner.

IAEA Bases:

SSR-2/2 (Rev.1)

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.

SSG-76

4.38. Shift rounds should be conducted regularly by operating personnel to identify actual and potential problems and conditions that could affect the functioning of equipment. The frequency of equipment inspections should be determined on the basis of the safety significance of the failure of the item of equipment, and this frequency should be adjusted when operating conditions or maintenance conditions change. Shift rounds should also cover remote areas of the plant and items of equipment that are difficult to access.

4.40. Operating personnel who are assigned the task of conducting shift rounds should be made responsible for verifying that operating equipment and standby equipment operate within normal parameters. They should take note of any equipment that is deteriorating and of factors that might affect environmental conditions, such as water leaks, oil leaks, broken light bulbs and changes in building temperature or the quality of the air.

4.43. Operating personnel should check other indications, if possible, when unexpected readings are observed. Prompt action should be taken to investigate the causes of abnormal or unexpected indications so that prompt corrective action can be undertaken.
4.44. To ensure best practice in identifying and reporting deviations, specific training should be provided to the operating personnel undertaking shift rounds. In addition, supervisors should coach shift teams and individual operating personnel in achieving a consistent standard in identifying and reporting plant deficiencies.

SSG-77

8.1. Control of materials and housekeeping can impact the progression of hazards and their consequences.

8.2. Hazard management should include specific plant walkdown procedures to be conducted periodically, as well as before and after an event. The results of these walkdowns should be properly documented. These walkdowns should ensure that the structures, systems and components needed for prevention, protection and mitigation of hazards and for coping with the impact of hazards are in place and kept operational. Some examples of walkdowns are the following:
(a) Ensuring that non-essential flammable materials, including ignition sources (e.g. flame cutting, welding), are removed from the vicinity of activities;
(b) Ensuring that fire extinguishing equipment is present on the site and operable;
(c) Ensuring that culverts are kept clear, as they can have a significant impact on the ability of the site drainage systems to dewater the site;
(d) Ensuring that loose materials (especially heavy objects) are cleared away or tied down, as they could create airborne missiles if extreme winds occur.

Some of these actions are of particular importance when an external hazard (e.g. extreme winds, flooding) is forecast, but proper housekeeping is required to be in effect at all times, even if some actions are particularly important only at times when an external hazard is forecast (see Requirement 28 of SSR-2/2 (Rev. 1) [1]).

3.6. FIRE PROTECTION

3.6 (1) Issue: The plant does not always effectively control activities related to fire doors and storage to ensure fire risks are minimized.

The team noted the following:

Fire load

- Workers assigned to a hot work and workers who request the creation of a laydown area were briefed on the additional risks and expectations regarding the fire load and storage requirements. However, other workers are not trained/ briefed to understand the specific risks and expectations across the plant and there was no specific signage.
- During a walkdown in areas where the fixed firefighting system was isolated for defect repairs, and where no additional fire loads or unauthorized storage were allowed, the team observed:
  - Four drums of oil were stored in the diesel generator AX/AY room without any label or authorization; and the same deviation had been raised 10 days before during another field walkdown but had still not been addressed.
  - There was a temporary storage area for painting the AY diesel day-tank room. The inventory list on the assessed fire load form did not comply with the stored material, which included additional combustibles such as plastic, tools, and trash.
  - There was another storage for painting materials in AX diesel day-tank room without any label or fire load assessment. Other flammable materials, such as papers and electrical equipment were also found in this room.
- A decay heat penetration maintenance toolbox used during outages was left in an unmarked storage area. Three containers each containing 2-3 litres of hydraulic oil and penetrating oil were placed inside the toolbox.
- Two large, open waste oil containers with about 20 litres of oil, each near to the cabinet with a sign “Shift Operation CW8 Store”, were stored on the same floor as the cooling water pump motor (8B and 8D) without a storage authorization and there was no visible indication that fire risk of the additional oil was assessed.
- The shift operation TG7 oil storage authorization document posted on the storage fire door did not include information on what category of flammable material could be stored in the cabinet and did not include information about the quantity of flammable material authorized to be stored in this cabinet.
- The shift operation TG7 oil storage had the authorization document posted on the door without information on who authorized the cabinet in this area.
- There was no surveillance inspection of the shift operation TG7 oil storage recorded on the tracking list since the authorization document was issued in 2017.

Fire doors

- In the AX day-tank room, a fire door was wedged open with a piece of vacuum cleaner without any risk assessment, as required by the Technical Guidance Note about fire doors.
- In essential supply building, at the 8-meter level, the fire door FD/0269 was found not fully closed. There was no defect raised for this deficiency with the door closing mechanism.
- The fire door leading to the Spent Fuel Pond room could not be automatically closed, and it was not checked closed when plant staff entered the room. The plant has clear expectation that fire door status must be checked when someone passes through.
- The fire door FD/0264 needed to be hand-closed by operators as it was found not fully closed owing to a defective closing mechanism.

- Two staff members have not checked the closure of the fire door when entering to the Central Control Room. This door did not latch fully closed due to a deficiency of the door closing mechanism.
- The shift operation TG7 oil storage fire door did not fully close because the closing mechanism located on the door was broken; moreover, it did not have a defect tag.

Without effective closure of fire doors and control/assessment of fire loading, the consequences of fire which could have an adverse impact on the safety of equipment and personnel could increase.

Recommendation: The plant should improve the closure of fire doors and control/ assessment of fire loads in the plant to minimize the consequences of fire to equipment and personnel safety.

IAEA Bases:

SSR-2/2 (Rev. 1)

Requirement 22: Fire safety
The operating organization shall make arrangements for ensuring fire safety.
5.21. The arrangements for ensuring fire safety made by the operating organization shall cover the following: adequate management for fire safety; preventing fires from starting; detecting and extinguishing quickly any fires that do start; preventing the spread of those fires that have not been extinguished; and providing protection from fire for structures, systems and components that are necessary to shut down the plant safely. Such arrangements shall include, but are not limited to:
(b) Control of combustible materials and ignition sources, in particular during outages;

SSG-77

9.4. The maintenance, testing, surveillance and inspection for the site and plant should include general hazard protection measures as well as measures for protection against specific hazards. Hazard protection and mitigation features that should be inspected, maintained and tested include the following:
(e) Engineered structures, fittings and barriers (e.g. fire doors, watertight doors, dampers, penetrations);

9.5. Maintenance, testing, surveillance and inspection activities can be conducted during outages or on-line states of the plant. The on-site hazard protection measures should be complemented by alternative measures so that an appropriate level of defence in depth is continuously maintained during the off-line states of those original measures owing to maintenance, testing, surveillance and inspection. Some examples of alternative measures are the following:
(a) Sustaining fire barriers, fire hazard monitoring equipment and firefighting equipment (e.g. assigning a fire watch during fire sensor repairs, securing water lines or fire extinguishers while fire water systems are partially isolated);

9.7. The operating organization should consider additional combustible materials and ignition sources during the maintenance and modification activities.
10.7. Familiarization and training for personnel responsible for the initiation or authorization of relevant work activities should cover specific topics regarding hazard prevention, protection

or mitigation, including the following:

(a) For fire hazards:

- How to control combustible materials and ensure that area limitations on fire loads9 are met;
- The control of combustible materials and ignition sources and the potential impact of the materials and the sources on the permissible fire load in an area;
- The stipulations of the work permit system, the specific situations in which a fire watch is necessary, and the risk of introducing potential ignition sources into fire compartments11 containing structures, systems and components important to safety;
- Instructions on work implementation and general fire safety training so that the personnel can readily recognize various fire hazards at the plant and can understand the implications of introducing combustible materials or ignition sources into areas containing components important to safety;

SSG-76

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

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

4. MAINTENANCE

4.5. CONDUCT OF MAINTENANCE WORK

The team observed that the plant maintenance activities are not always prepared, implemented and controlled in a manner that minimises the risks to equipment and personal safety. The plant has 34 instances of maintenance rework in the period of May 2023 to September 2023. For example, some equipment was observed where bolts that did not have at least two threads beyond the end of the outer face of the nuts, which is considered industry best practice. The team made a suggestion in this area.

4.6. MATERIAL CONDITION

The team identified that the material condition of some plant systems, structures, and components is not effectively maintained to minimise the risks to the safety and reliability of the plant. For example, the team identified that oil leaks of various amounts exist on all diesel generators. A number of oil leaks were identified in the reactor building basement underneath the lube oil coolers of 8A and 8B Gas Circulators. Cables were observed not fully secured and fixed on cable trays, and the sheaths of cables on the refuelling machine was also found damaged. The team identified a recommendation in this area.

The team also observed hoses in the storage container used for Decay Heat Feedwater Emergency Readiness in the Unit Loading Bay did not have FME covers. In addition, there were some pipes without FME covers in the CO2 Plant seismic storage and some pieces of old tape were placed 5cm away from the Spent Fuel Pond (SFP). The team encouraged the plant to improve in this area.

DETAILED MAINTENANCE FINDINGS

4.5. CONDUCT OF MAINTENANCE WORK

4.5 (1) Issue: The plant maintenance activities are not always prepared, implemented and controlled in a manner that prevents equipment failure.

The team noted the following:

- The plant has self-identified 34 instances of maintenance rework in between May 2023 to September 2023 when over 10000 maintenance activities were carried out during this statutory outage period. For example, after Unit 8 outage, five out of 32 secondary shutdown nitrogen trip valves have been found leaking following maintenance work resulting in chemistry parameter entering an action level.
- On low pressure turbine casings for both Unit 7 and Unit 8, it was observed that there were more than 20 bolts that did not have at least two threads beyond the end of the outer face of the nuts in accordance with best practice to ensure secure fastening and engagement.
- On several other occasions, such as the casing for the reactor sea water pump (8BY), none of the five bolts had at least two threads beyond the end of the outer face of the nuts to ensure secure fastening and engagement.
- The protective cover of a 110V DC terminal block, which was removed at the beginning of a job by a technician, was not returned to its original position after completion of the testing task on 3.3 Auxiliary Transformer 8DX 11 kV Unit board 8D. This was not identified after the final configuration was checked by a worker as well as by an independent verifier. When asked, the technician opened the cubicle again, found the protective cover at the bottom of the cubicle, and returned the protective cover to its original position.
- After corrective maintenance work of a drain plug leak on Forced Air Cooling Air Compressor, the maintenance technicians did not re-check the bearing casing drain plug to verify proper leak tightness before leaving the job site. They only visually checked the leak catcher installed beneath the bearing casing. A quick visual check of the oil catch, without a visual check of the drain plug itself, was not sufficient to ensure that the leak stopped.
- The maintenance technicians did not clean the job site floor of several oil drops that fell on the floor underneath their trolley after job completion, before leaving the job site of corrective maintenance work of the drain plug leak on Forced Air Cooling Air Compressor.
- In the reactor building of Unit 8, a scaffold from the last outage was touching the main steam piping insulation at several locations. A ladder mounted on the scaffold to reach the next elevation was touching the bypass steam valve actuator SS76Y2.
- In the Quadrants A and B area (main steam line area), several drain valve actuator extended spindles were in contact with the scaffolding erected for plant maintenance. The plant has clear expectations that scaffolding should not be in contact with plant systems, structures and components.
- In the Quadrant B area (main steam line area), three cables from the electrical cabinet for the drain valves were in contact with the erected scaffolding.
- Open ends on three temporary test instruments lines on Turbine 7 were observed, not protected against foreign material intrusion after the test instruments were removed.
- Disconnected low voltage cable ends were observed beside the 7MK149B gauge without insulation and a tag.

Without adequate preparation, implementation and control of maintenance activities, risk of equipment failure can increase.

Suggestion: The plant should consider improving its preparation, implementation and control of maintenance activities to reduce the risk of equipment failure.

IAEA Bases:

SSR-2/2 (Rev. 1)

4.30 The operating organization shall encourage plant personnel to have a questioning attitude and to make appropriate and conservative decisions, so as to minimize risk and to maintain the plant in a safe condition.

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.

7.11 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.

4.6. MATERIAL CONDITION

4.6(1) Issue: The material condition of some plant systems, structures, and components is not effectively maintained to minimise the risk to the safety and reliability of the plant.

The team noted the following:

- On the Pile Cap of Unit 8, hydraulic jacking equipment was leaking oil, creating a 5cm*5cm puddle approximately 10 cm from the top of the reactor floor. An oil pad beneath it was soaked with oil. No defect tag was present.
- CX and CY Diesel generators in the Northwest Diesel House had large amount of oil (about 2m*2m*0.01m) underneath, from leaks which were not identified and tagged by the plant. There were multiple minor oil leaks and traces along the diesel casing flange of these two diesels. It was later identified that all diesel generators have oil leaks to a different extent.
- There are a large number of oil leaks in the oil bund underneath the lube oil cooler of 8A and 8B Gas Circulators. Some of these are about 50cm*50cm. These leaks were not identified with deficiency tags. The plant indicated that the last outage of this Unit was completed in June 2023.
- Several oil leaks were observed underneath the bearings of Turbine Generators for Unit 7 and 8, the oil leaks were 20cm*30cm, and at least three such oil leaks were not identified by the plant.
- Oil leaks were observed underneath the coupling of Main Feed Water Pumps for Unit 7 and 8, at least two oil leaks were not identified by the plant.
- There were many electrical cables in the turbine building with oil trace, oil drops, oil and dust mixture on the surface.
- One electrical safety protective barrier of a 110V DC terminal block in a cubicle was seen missing at the beginning of an electrical maintenance job on the 3.3 Auxiliary Transformer 8DX 11 kV Unit board 8D. This was not recognized by the workers as a material condition or electrical safety gap and the workers did not raise the Work Request on this deficiency after the job completion. In another case, another electrical safety protective barrier of a 110V AC terminal block was seen missing in a cabinet at the beginning of the control and instrumentation job on calibration of thermocouple trip amplifier and loop check to post-trip sequencing equipment of train Y. This was not recognized by the plant workers as a material condition or electrical safety gap and they did not raise a Work Request on this deficiency after the job completion.
- Water leaks
  - There was a water leak with about 2 drops per second on the Main Feed Water Pump for Unit 7. This water leak was not identified by the plant.
  - There was water dripping from the ceiling at the location of CR0052HB in the Turbine Building, and no deficiency tag was apparent.
  - Turbine lubrication oil cooler 7C main flange was leaking sea water causing surface corrosion of the external surface of the cooler.
  - There was a water leak dripping from turbine ancillary systems affecting thermal insulation cladding on several pipes on the -9 m level below the Turbine 7.
  - Nine tubes of about one inch diameter located one above another were affected by sea water leaking from the top located pipe beside TG7ACW11C.
- The external CO_2 plant has not been designed with an appropriate drain, such that large paved areas were covered by water puddles, up to a few cm deep. This was adjacent to the open air high and low pressure CO_2 system components and pipework.

- Cable trays in the CO_2 plant along the fence, especially at the back fence, were completely corroded, and cables were exposed to environmental degradation. Large rust pieces were spalling from cable trays and conduits.
- In the south-west essential supply building, concrete spalling was observed on a 30cm x 15cm section of wall at floor level.
- Cable conditions detected by the team:
  - Cables were observed not properly secured and fixed in cable trays.
  - Sheathing of cables on the refuelling machine were damaged.
  - Thermal insulation of small bore instrument and gland pipework supplying 7B1 and 7B2 governor valves were significantly damaged and missing at some places.
  - Several electrical cables were routed across the sharp edge of an oil collection tray underneath 7B1 governor valve.
  - There was an untagged damaged cable under the Unit 8 generator near to the AD758661 (415 V) electric cabinet. The cable and some other cables around were not secured according to plant standards.

Without effectively maintaining the material condition of plant systems, structures, and components, there is an increased risk that the safety and reliability of the plant can be compromised.

Recommendation: The plant should improve the material conditions of plant systems, structures, and components to minimise the risk to plant safety and reliability.

IAEA Bases:

SSR-2/2 (Rev. 1)

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

5. TECHNICAL SUPPORT

5.1. ORGANIZATION AND FUNCTIONS

The plant has introduced a weekly Medium Term Operational Risk (MTOR) meeting where the plant monitors progress and discusses mitigation actions of risks which may not necessarily need an investment, or immediate intervention but warrants close monitoring. The plant has also developed an easily accessible database tool where all risks are logged that can affect plant operation and which need attention by the plant in the next 12 months. The MTOR meetings have improved cross functional discussions at the plant. The team recognized this as a good performance.

The team identified that seismic controls are not always strictly implemented in seismically qualified areas of the plant. Even though the plant has implemented an improvement programme in the area of seismic control, which includes walkdowns and training, the team noted several items in seismically controlled areas not systematically secured. The team made a suggestion in this area.

5.2. SAFETY ASSESSMENT

During the mission the team noted that actions from the latest Periodic Safety Review (PSR) were not completed in a timely manner. For example, the safety case health checks introduced as part of the PSR process, raised several actions, and nine of these actions were not yet completed during the PSR closeout review in 2019 and, by the time of the mission, four of these actions were still not completed after having been rescheduled several times. The team also observed that the PSR identified 41 issues with low level significance for which 50% of the actions had not been completed. The team encouraged the plant to make further efforts to complete all actions from the latest PSR.

5.3. PROGRAMME FOR LONG-TERM OPERATION

The team observed that the plant's ageing management activities are not comprehensive and systematic. The team recognized that the plant had several programmes and activities that manage ageing, however, the team identified that ageing management activities were not coordinated and reviewed against the attributes of an effective ageing management programme. The team made a suggestion in this area.

5.5. SURVEILLANCE PROGRAMME

The team noted that the plant equipment reliability programme is not always effective at preventing abnormal conditions that challenge safe plant operation. During the mission the team identified that the plant has a comprehensive equipment reliability programme, however, the team noted that the system health of several important systems indicated red and amber status, in part due to a high number of equipment deficiencies. Further the team assessed that the total backlog of open deficiencies at the plant was high, and deferrals of surveillance testing were present due to equipment reliability issues. The team made a recommendation in this area.

5.6. PLANT MODIFICATION SYSTEM

The plant has adopted an Electronic Key Management System for personnel access to laptops, keys, and USB removable media across the plant. The system ensures that mitigations are in place for all plant programmable equipment, such as when hardware or software of plant computer systems is modified. The system is also used in the Central Control Room, whereby operators can access tablets and connect them to installed connections points from which key plant parameters can be monitored in case of an event. The team recognized this as a good practice.

The team identified that plant modifications are not always fully completed and reviewed in time to maintain plant effective configuration control. In recent years, an increasing trend of plant configuration events has occurred and the team noted that several condition reports have been raised because relevant plant procedures had not been updated to reflect modifications. The plant indicator for the target for closing modifications (including document amendments) within six months of implementation was red and this value had slightly increased during 2023. The team made a suggestion in this area.

DETAILED TECHNICAL SUPPORT FINDINGS

5.1. ORGANIZATION AND FUNCTIONS

5.1 (1) Issue: Seismic controls are not always strictly implemented in seismically qualified areas of the plant.

The plant has implemented an improvement programme to address seismic control which includes walkdowns and training. The housekeeping procedure for seismic standards states that "Stored mobile or wheeled equipment must be chained to floors and walls, have brakes applied or wheels chocked. The safe distance shall be more than 30 cm." During the mission the team noted several unsecured items in seismically controlled areas that were not effectively secured which could impact seismically qualified equipment, for example:

- In the room R8B01R01 which contains seismically qualified control panels, there was an air conditioning unit that was mounted on a temporary bench built from scaffolds which was not effectively secured to either the wall or the floor.
- Within the seismically qualified CO2 plant there is a designated, marked storage area for mobile trollies, however a trolley was identified outside the designated storage area, which was not chained nor had its brakes applied. Inside the storage area there were many items which did not appear to belong there.
- In the CO2 plant control room, a fire extinguisher next to the door inside the room was not restrained although it is explicitly stated on the entrance door that permanent mobile equipment shall be fixed as it is a seismically controlled building.
- In the reactor building of Unit 7, a Burst Can Detection trolley was less than 30 cm from sensitive cabinets.
- In reactor building of Unit 7, an old computer programming terminal VPU was stored in a seismic area on a trolley which was not chained to the floor and wall.
- In the reactor building, in a seismically controlled area, a trolley (ID 776153) carrying an engine was stored with the brakes applied as per the standard, but the brakes were not working effectively, and the trolley could move easily.
- In reactor building unit 8, at Level 32, Charge Hall Area, which is a seismically controlled area, a rack stand cart was left unsecured next to CO2 Control Panel LEH 8-1300. Multiple other items were found stored but not properly secured.
- On the reactor Unit 8 pile cap an inspection mirror was placed in a "keep clear" seismic area.

Without strictly implementing seismic controls in seismically controlled areas, unsecured items could pose hazard to safe operation of plant and equipment in a seismic event.

Suggestion: The plant should consider more strictly implementing seismic controls in seismically controlled areas.

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)

4.26 All activities important to safety shall be carried out in accordance with written procedures to ensure that the plant is operated within the established operational limits and conditions. Acceptable margins shall be ensured between normal operating values and the established safety system settings to avoid undesirably frequent actuation of safety systems.

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 walk downs of the plant by the plant managers.

SSG-77

3.1. The operating organization should establish a set of hazard management measures to ensure that the plant can be protected against hazards by suitable design and operational activities — including prevention and mitigation of the impact of, and coping with the consequences of, hazards or credible combinations of hazards, according to SSG-64 [4] — in an integrated management system.

3.18. The operating organization should establish separate (or integrated, where appropriate) procedures for different types of hazard. These procedures should provide clear instructions to the personnel on actions to be implemented if precursors or indications of hazards are observed or if hazard induced precursors to initiating events occur.

NS-G-2.13

5.33. Plant walkdowns are one of the most significant components of the seismic safety evaluation of existing installations... These walkdowns may serve many purposes, such as: 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. Walkdowns should also be used to consider outage configurations that are associated with shutdown modes.

5.3. PROGRAMME FOR LONG-TERM OPERATION

5.3 (1) Issue: The plant's ageing management activities are not comprehensive and systematic.

The plant has several programmes and activities that manage ageing within areas such as corrosion, maintenance, obsolescence, chemistry, life asset management plans and at the time of the mission were conducting an industry Member support mission in this area, however, the team noted:

- The plant presented a corporate guide on ageing management, which takes into account the IAEA Safety Standards, however this guide is not yet implemented at the plant.
- Though the plant recognized the potential gap in ageing management with respect to IAEA Safety Standard, the plant programmes and activities are not coordinated by an overarching ageing management programme.
- The plant has not reviewed that the ageing related programmes and activities meet the 9 attributes of an effective ageing management programme.
- The plant health committee follows up and evaluates the individual plant programmes that are relevant for ageing management, however, the overall ageing management approach is not a separate topic on its agenda.
- The latest periodic safety review (PSR) conducted in 2017 issued 5 category B actions (Safety significant issue). One action within Safety factor 4 Ageing, covering the implementation of preventive maintenance on critical spare parts was closed, however the action has not been completed.
- During recent years, the plant obsolescence management programme had significantly reduced the number of obsolete spares for Single Point Vulnerability (SPV) and critical 1 components. However, to date, spares for 60 SPV and 9020 critical 1 components are left to be reviewed. The plant has not developed a plan with targets in the short or medium term to complete assessment of the remaining unevaluated components.
- On 1 January 2021, the Reactor 7 tripped due to a transformer fault. During this event the CX Diesel failed to start. The failure to start was attributed to an air leak on the AC3A and stiction on AC3B because ageing effects had not proactively been addressed.

Without comprehensive and systematic ageing management activities, plant systems, structures, and components might not fulfil their safety functions throughout the life of the plant.

Suggestion: The plant should consider improving its ageing management activities to ensure ageing of systems, structures, and components is properly managed.

IAEA Bases:

SSR 2/2 (Rev.1)

Requirement 14: Ageing management
4.50 The ageing management programme shall determine the consequences of ageing and the activities necessary to maintain the operability and reliability of structures, systems and components. The ageing management programme shall be coordinated with, and be consistent with, other relevant programmes, including the programme for periodic safety review. A systematic approach shall be taken to provide for the development, implementation and continuous improvement of ageing management programmes.

SSG.48

2.6 Effective ageing management throughout the lifetime of SSCs requires the use of a systematic approach to managing the effects of ageing that provides a framework for coordinating all activities relating to the understanding, prevention, detection, monitoring and mitigation of ageing effects on the plant's structures and components.

2.13. Ageing management programmes should be developed using a structured methodology, to ensure a consistent approach in implementing ageing management.

2.15. Where existing plant programmes are not sufficient, they should be improved or new ageing management programmes should be developed and implemented.

2.18 Effective ageing management is in practice accomplished by coordinating existing plant programmes and processes (or elements thereof that are relevant to ageing), as well as external activities such as research and development, and by implementing, coordinating or taking credit for other specific actions.

2.24 The effectiveness of ageing management should be periodically reviewed to maintain plant safety and to ensure feedback and continuous improvement.

2.25 Nuclear power plant safety can be impaired if the obsolescence of SSCs is not identified in advance and corrective actions are not taken before the associated decrease in the reliability or availability of SSCs occurs.

5.5. SURVEILLANCE PROGRAMME

5.5 (1) Issue: The equipment reliability programme is not always effective to prevent abnormal conditions.

The plant equipment reliability programme has comprehensive governance and oversight forums, such as plant health committee and system review boards, with the overall purpose to proactively enhance the reliability of plant equipment, however, the team noted:

- The system health of several important systems indicated red (unacceptable) and amber (needs improvement) status due in part, to a high number of equipment deficiencies in the plant physical condition metrics. For example, the refuelling machine, primary circuit sampling system, and emergency diesel generators.
- The cumulative effect on plant equipment reliability due to the total amount of deficiencies has not been assessed. The total amount of work requests at the plant was 6952 at the time of the mission and was categorized as follows:
  - 446 corrective and deficient (non-outage);
  - 336 corrective and deficient (awaiting an appropriate plant outage to address);
  - 2429 low significance deficient, 226 are on ‘criticality 1’ components;
  - 3741 other work requests, 611 on ‘criticality 1’ components.
- The system health indicator programme (SHIP) contains many indicators, one of which is system walkdowns. The system health walkdowns conducted for emergency diesel generators did not record any leaks in the feedback form, however, several important leaks around the different emergency diesel engines were observed by the review team and the diesel CY had to be taken out of service for deep cleaning before Maintenance Schedule (MS) surveillance test could be conducted.
- In October 2023, 144 Maintenance Schedule tasks (MS) had passed the maximum grace period. 83 MSs were in the second half of grace while the plant key performance indicator (KPI) targets less than 50. In September 2022 the total number of deferrals was 85 and it was concluded that 38% of the deferrals were due to equipment reliability issues causing the plant to remain out of service when the maintenance was due. When the MS related plant is unavailable, it may challenge the safety redundancy margins.
- Since 2021 there has been 4reheater leaks across both reactor units which challenge system performance and require chemistry programme mitigations.
- A technical review based on interviews was undertaken of effects on plant equipment reliability from the new outage cycle (‘new rhythm’). Although the plant remained within its safety case, the level of rigour applied to this review was inconsistent across the engineering functions which resulted in some unanticipated equipment reliability issues as a result of the increased number of outages.
- On 6 September 2022, an event occurred causing a bulk moisture filter unavailability leading to short duration technical specification limiting condition of operation. The direct cause was the increased carbon deposition on bulk moisture system filters and the root cause was related to the changed outage frequency and that the preventive maintenance frequency had not been changed to match the change in outage frequency.
- The plant has experienced problems with control rod relay failures due to ageing in service. With the new refuelling outage cycle, these failures have been occurring more often owing to more regular demands on the control rods. The Operational Safety Review Committee commissioned a review of startup issues which showed that in the period considered, there were seventeen control rod freeze faults, 70% of which were related to relay failures. During start-up the reactor is operated in manual reactivity control, and rod freeze faults challenge the operations staff due to control rod relay reliability. On 27 January 2022, a

minor reactivity transient event occurred during startup due to a rod relay fault. The plant has implemented changes to the relay maintenance programme as a result of this OPEX report.

Without an effective equipment reliability programme abnormal plant conditions can challenge safe plant operation.

Recommendation: The plant should improve the equipment reliability programme to prevent abnormal plant conditions.

IAEA Bases:

SSR 2/2 (Rev.1)

Requirement 31: Maintenance, testing, surveillance and inspection programmes
The operating organization shall ensure that effective programmes for maintenance, testing, surveillance and inspection are established and implemented.

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.

8.5. The frequency of maintenance, testing, surveillance and inspection of individual structures, systems and components shall be determined on the basis of:
a) The importance to safety of the structures, systems and components, with insights from probabilistic safety assessment taken into account;
b) Their reliability in, and availability for, operation;

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

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

8.12 A management system for managing and correcting deficiencies shall be established and shall be used to ensure that operating personnel are not overly burdened. This system shall also ensure that safety at the plant is not compromised by the cumulative effects of these deficiencies.

SSG-74

2.27 MTSI activities should be planned and coordinated effectively.
5.13 This work planning and control system should also ensure that the concept of defence in depth is applied (see para. 3.3) and that MTSI activities are properly scheduled and can be completed (by either plant personnel or contractors) in a timely manner. The work planning system should also ensure adequate availability and reliability of SSCs important to safety.

5.15 Waivers or deferrals of scheduled MTSI activities should be minimized. Such waivers or deferrals should only be authorized if justified by plant conditions and after an appropriate review of the effects on plant safety has been performed.

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

10.10 The frequency of inspections at a nuclear power plant should be chosen on the basis of conservative assumptions to ensure that any degradation of SSCs is detected before it can lead to failure.

5.6. PLANT MODIFICATION SYSTEM

5.6 (a) Good practice: Electronic Laptop Lockers and Key Storage

The plant Electronic Key Management System has been deployed for plant access laptops, keys, and USB removable media across the site to ensure mitigations are in place for all plant programmable equipment. The system ensures that only authorized people have access to areas and equipment important to safety, for example, when hardware or software of plant computer systems is modified. The lockers are also used in the central control room where the Electronic Key Management System contains electronic tablets. During events that could result in loss of control room instrumentation, operators can access the tablet and connect them to installed connections points from which they can monitor key plant parameters.

The Electronic Key Management System lockers use fingerprint technology to authenticate users to retrieve their key, media or laptop. The system can be configured with built in charging and a Radio-Frequency Identification device tracking if required.

Figure 5.1: Laptop lockers using Electronic Key Management System

5.6 (1) Issue: Plant modifications are not always fully completed and reviewed in a timely manner to maintain effective plant configuration control.

The team noted the following:

- The plant target for closing plant modifications (including to complete all documentation changes associated with the modification) is less than 6 months after implementation, and the plant target is to have less than five open modifications to be green. The current number is eighteen, which is red (criteria for red is >10) and the number has been slightly increasing during 2023.
- In the period between April to September 2023 there were 55 (33% of total) plant modifications open after implementation, several of these are due to documentation backlog that have not been finalized, such as maintenance procedures and drawings.
- In recent years, an increasing trend of plant configuration events has occurred. For example, in September 2022 the major air ingress prevention was not available due to plant configuration error and the root cause was due to insufficient details in operation return to service procedure. On 1 March 2023 the plant discovered that a plant modification had not updated the maintenance procedure for the gas circulator variable frequency converter.
- On 25 June 2023 it was discovered that a plant modification on the unit 8 decay heat system had failed to add new steam traps onto the operations plant check sheet which led to possible risk of damage to the plant or the personnel.
- On 26 June 2023 it was discovered that a plant modification had missed updates to the operational reactor startup check sheet for return to service. Operating experience from plant modifications is used during refresher training. However, there are no formal trends and learning cycle related to engineering change shortfalls. Post-job debriefings (PJDs) are not routinely used within the engineering change process.

Without fully and timely completing and reviewing plant modifications, safety system, structures and components and their operation could be compromised.

Suggestion: The plant should consider fully and timely completing and reviewing plant modifications to ensure that the plant configuration is always up to date.

IAEA Bases:

GSR Part 2

Requirement 8:
The management system shall be documented. The documentation of the management system shall be controlled, usable, readable, clearly identified and readily available at the point of use.

4.18. Revisions to documents shall be controlled, reviewed and recorded. Revised documents shall be subject to the same level of approval as the initial documents.

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 10: Control of plant configuration
4.38. Controls on plant configuration shall ensure that changes to the plant and its safety related systems are properly identified, screened, designed, evaluated, implemented and recorded.

Requirement 11: Management of modifications
4.40 Modification control, in compliance with the requirements set out in SSR-2/1 [2], shall ensure the proper design, safety assessment and review, control, implementation and testing of all permanent and temporary modifications.

4.42 The plant management shall establish a system for modification control to ensure that plans, documents and computer programs are revised in accordance with modifications.

4.43 Before commissioning a modified plant or putting the plant back into operation after modifications, personnel shall be trained, as appropriate, and all relevant documents necessary for plant operation shall be updated.

SSG-71

4.27 Consistency is required between modifications, design requirements and plant documentation (see Requirement 10 and para. 4.38 of SSR-2/2 (Rev. 1) [1]). When modifications are made to structures, systems and components or process software, the relevant plant documentation should be modified accordingly.

4.28 Configuration management should also be used to ensure that the implementation of the modification is in accordance with the design requirements as established in the design documentation.

7.16 The final approval of modifications before routine operation should be based on the successful completion of the commissioning tests and verification that the information and experience obtained confirms compliance with regard to the design.

6. OPERATING EXPERIENCE FEEDBACK

6.2. THE MANAGEMENT SYSTEM AND THE ROLE OF MANAGEMENT

The plant has decided to split its well-established Organizational Learning Challenge Board (OLCB) into two parts: one proactive focused on learning and organized monthly, and one reactive, focused on events and organized weekly. Clear distinction between reactive and proactive OLCB provides dedicated time to review the proactive learning activities such as cross-functional self-assessments, benchmarks, trend reports, health of the organisational learning programmes, fleet learning, etc. Proactive OLCB also provides a forum for examining the potential risk of events before they occur, enabling a proactive response where necessary. The team identified this as good performance.

6.4. SCREENING

The team observed that the screening and prioritization process of the plant does not always ensure that events are evaluated on their actual or potential consequences for safety. Event priorities are not always assigned in accordance with the process check sheet and Condition Reports are sometimes closed and fed into trending without clear evidence of actions taken or planned. The team made a suggestion in this area.

6.8. COMMUNICATION: USE, DISSEMINATION AND EXCHANGE OF INFORMATION

The team observed that the plant has established several formats of Operating Experience (OPEX) information. One of them is an outage OPEX package, bringing Just-In-Time information for outage milestones and different mode changes like re-pressurization and purging CO2, reactor blowdown, purge to air, etc. This outage OPEX package is produced to heighten awareness to unique configurations and events that have happened across the fleet during previous outages. The team identified this as good performance.

DETAILED OPERATING EXPERIENCE FINDINGS

6.4 SCREENING

6.4 (1) Issue: The screening and prioritization process does not always ensure that events are evaluated on their actual or potential consequences.

The team noted the following:

- The screening and prioritization flowchart described in Appendix D of the plant procedure "Organizational Learning Process, Site Screening" does not clearly reflect potential risk and safety significance. Appendix D, Table D1 of the procedure contains additional considerations for condition report prioritization guidance but is not aligned with the flowchart. For example, Table D1 describes priority 4 (P4) as applicable for low level events which, individually, are without significant actual or potential consequences. However, the flowchart in appendix D shows P4 as being an event which the plant accepts to reoccur.
- A condition report (CR 1186739) related to excessive standing oil in a pit underneath the diesel generator BY was prioritized as P4. The condition report was raised in June 2020. Work order to repair the leak was originally scheduled to be completed in July 2022, later changed to 2021 as a repair two years after the identification of the defects was identified as unacceptable. This condition report was an example of elevated fire risk on a plant system with high safety importance, but this was not reflected in the event prioritization or in repair planning.
- A condition report (CR 1281009) from July 2022 related to management of stator water chemistry alarms was assigned P4 instead of P3. The CR states that several alarms were set incorrectly, several alarms did not reflect the latest specification and there was potential to operate outside of permitted ranges without initiation of an alarm. Specific actions were proposed in the CR by the originator, such as how to set the alarms and their required values. When screened the CR was closed and fed into plant trending only. The CR was closed without clear supporting evidence. There is a cross referenced CR which details actions relating to procedures but not physical plant changes.
- A sample of NPE30B events (discovery that non-safety related plant is in an inappropriate configuration or duty) was screened. The condition report prioritization guidance gives a typical priority of P3 for such events. Thirty-one out of forty-four between 2022 and 2023 were prioritized as P4 instead of P3 based on the guidance. Only thirteen of these condition reports were prioritized as P3.

Without proper event screening and prioritization, events may not be investigated and addressed commensurate with their significance to prevent recurrence.

Suggestion: The plant should consider improving its screening and prioritization of plant events to prevent recurrence.

IAEA Bases:

SSR-2/2 (Rev. 1)

5.28 Events with safety implications shall be investigated in accordance with their actual or potential significance. Events with significant implications for safety shall be investigated to identify their direct and root causes, including causes relating to equipment design, operation and maintenance, or to human and organizational factors. The results of such analyses shall be included, as appropriate, in relevant training programmes and shall be used in reviewing procedures and instructions. Plant event reports and non-radiation-related accident reports shall identify tasks for which inadequate training may be contributing to equipment damage, excessive unavailability of equipment, the need for unscheduled maintenance work, the need for repetition of work, unsafe practices or lack of adherence to approved procedures.

SSG-50

2.31 In order to apply a graded approach to operating experience, identified issues should be screened in a timely manner to evaluate their significance on the basis of their actual or potential consequences for safety. Written guidance with established criteria for significance should be used for the screening process. The screening process should determine the type of investigation or level of analysis for all reported issues, and necessary compensating or mitigating actions should be initiated commensurate with the significance of the issues.

2.33 Screening criteria should include the actual or potential consequences of reported issues for nuclear safety, radiation protection, protection of the environment and non-radiation-related safety.

2.35 Screening should include identifying and prioritizing any immediate actions that might be necessary, in accordance with the safety significance and potential for recurrence of a particular issue or in accordance with the significance of a developing adverse trend.

7. RADIATION PROTECTION

7.3. RADIATION WORK CONTROL

The team identified that contamination controls at the plant are not applied effectively to ensure resilience against potential contamination events. As examples, during the OSART mission, a radiation worker was contaminated externally and internally at the plant when working on a pressure transmitter from the reactor gas coolant processing system. In addition, gaps were found related to controls applied to discrete radioactive particles without the use of adequate detectors, radiologically contaminated areas not isolated and marked correctly, inappropriate behaviour for removing personal protective equipment, inadequate practices for measuring, recording, and informing radiation workers of the existing levels of radiation and contamination. The team made a recommendation in this area.

7.4. CONTROL OF OCCUPATIONAL EXPOSURE

The team identified that the plant does not systematically optimize radiation protection processes and controls to reduce potential occupational exposure to levels as low as reasonably achievable. Some examples include the lack of a formal, integrated programme to reduce the number of hot spots in the plant, failure to use temporary shielding to mitigate hot spot dose rates, tolerance of electronic personal dosimeter (EPD) alarms since condition reports are not elevated to plant level, survey procedure not adhered to, lack of information on radiation levels and contamination on signposting, and lack of questioning attitude to promptly detect and correct abnormal conditions in radiological instrumentation. The team made a suggestion in this area.

7.5. RADIATION PROTECTION INSTRUMENTATION, PROTECTIVE CLOTHING AND FACILITIES

The plant uses an electronic system with a systematic process for managing radiological protection instruments. The process links the health physicist to the instrument to be used, the verification test performed and the results. This avoids the use of defective or uncalibrated instruments and allows traceability of use only by authorized people. The team identified this as a good performance.

It is observed that immediate traceability of all radioactive sources in use, discarded or under disposal is not always effective, and the team encouraged the plant to improve in this area.

DETAILED RADIATION PROTECTION FINDINGS

7.3. RADIATION WORK CONTROL

7.3 (1) Issue: The plant contamination controls are not effectively applied to protect against possible contamination events.

The team noted the following:

- On 12 October 2023, a radiation worker was contaminated externally and internally at the plant when working on a pressure transmitter from the reactor gas coolant processing system. The counts at the gamma detector of the whole body contamination monitor, after the external contamination was removed, was about 460 Bq of contamination, calibrated to Co-60.
- A barricaded area contained some piping inside, and at the bottom a bag with a radiation tri-foil from the laundry. No postings or other information was visible. Later, a survey confirmed that the drain area below the bag was contaminated, and the area was set as C2.
- When exiting a contamination-controlled area an employee required help to remove his PPE for that area. Whilst doing so his shoe came off within an overshoe. This employee used his naked hand to recover the shoe from the overshoe potentially exposing it to contamination.
- During sampling the reactor coolant system:
  - Radiation protection technicians checked only for dose rates levels and did not perform a contamination check (baseline) inside the cabinet where the potentially contaminated particulate and charcoal filters are located.
  - One of the two technicians used gloves and gantlets, but the other did not. They handed over CO2 detectors between them, thus potentially cross-contaminating.
  - Contamination check was not done at the cabinet to ensure no residual external contamination remained on the equipment.
- During work inside room R4:
  - The radiation protection technician made a survey for radiation and contamination, before allowing the work to start. The radiation protection technician did not inform the workers of the detail of the measured dose rates and results of the contamination control; he only gave a thumbs up. The technician did not record the survey results and the plant said he would create a survey map later, by keeping the information in his memory.
  - The housekeeping standards at the area (dirt on the floor) are not suitable to prevent spread of contamination.
- The contamination control programme mandates routine survey for the hot laundry once a week. After daily hot laundry operation, experienced workers survey for contamination, sometime finding positive counts, and clean the facility. This is not captured in the current contamination control programme and the daily surveys are not recorded.
- There is no gamma detector or frisker at the whole body contamination monitor at the drinking water station facility inside the reactor building. The contamination control is made only by using a whole body contamination monitor for alpha/beta radiation in that place, therefore hot particles or discrete radioactive particles (DRPs), may remain unnoticed. DRPs are very difficult to detect and could be easily shielded, and large area detectors are not suitable to detect a DRP.

Without effective application of contamination controls the plant may not protect against personal contamination events that could lead to significant skin or committed doses.

Recommendation: The plant should improve its application of contamination controls.

IAEA Bases:

GSR Part 3

3.76. Employers, registrants and licensees shall ensure, for all workers engaged in activities in which they are or could be subject to occupational exposure, that:
(g) Appropriate monitoring equipment and personal protective equipment is provided and arrangements are made for its proper use, calibration, testing and maintenance;

3.90. Registrants and licensees:
(a) Shall delineate controlled areas by physical means or, where this is not reasonably practicable, by some other suitable means.
[…]
(c) Shall display the symbol recommended by the International Organization for Standardization [16] and shall display instructions at access points to and at appropriate locations within controlled areas.
(g) Shall provide, as appropriate, at exits from controlled areas:
(i) Equipment for monitoring for contamination of skin and clothing;
(ii) Equipment for monitoring for contamination of any objects or material being removed from the area;
[…]
(i) Shall provide appropriate information, instruction and training for persons working in controlled areas.

3.94. Employers, registrants and licensees, in consultation with workers, or through their representatives where appropriate:
(c) Shall make the local rules and procedures and the measures for protection and safety known to those workers to whom they apply and to other persons who may be affected by them; [...]

3.97. The type and frequency of workplace monitoring:
(a) Shall be sufficient to enable:
(i) Evaluation of the radiological conditions in all workplaces; […]

3.101. For any worker who regularly works in a supervised area or who enters a controlled area only occasionally, the occupational exposure shall be assessed on the basis of the results of workplace monitoring or individual monitoring, as appropriate.

3.102. Employers shall ensure that workers who could be subject to exposure due to contamination are identified, including workers who use respiratory protective equipment. Employers shall arrange for appropriate monitoring to the extent necessary to demonstrate the effectiveness of the measures for protection and safety and to assess intakes of radionuclides and the committed effective doses.

GSG-7

3.96. For each task that needs special radiological precautions to be taken, a radiation work permit should normally be prepared. The radiation work permit is issued by the persons in charge of the planning of the operations, in collaboration with the radiation protection officer. A copy of the radiation work permit should be provided to the supervisor of the work and should remain with the working team during the performance of the work. In addition to a description of the work to be performed, the radiation work permit can include:
(a) A detailed dose rate map of the working area and possible hot spots […];
(b) An estimate of contamination levels and how they could change during the course of the work; […]

3.105. The equipment to be used in the monitoring programme should be suitable for the types of radiation and the forms of radioactive material encountered in the workplace. […]

3.60. The radiation protection programme should document the following, with an appropriate level of detail: […]
(h) The arrangements for monitoring workers and the workplace, including the acquisition and maintenance of suitable instruments (see paras 3.97–3.128 and Section 7); […]
(i) The system for recording and reporting all of the relevant information relating to the control of exposures, the decisions regarding measures for occupational radiation protection and safety, and the monitoring of individuals (see paras 3.132–3.140 and Section 7) […]

7.133. The assessment of doses received by workers from exposure due to intakes of radionuclides may be based on the results of individual monitoring involving one or more of the following types of measurement:
(a) Sequential measurements of radionuclides in the whole body or in specific organs, such as the thyroid or the lung;
(b) Measurements of radionuclides in biological samples, such as excretions or breath;
(c) Measurement of activity concentrations in air samples that are collected using personal air sampling devices worn by the worker and that are representative of the air breathed by that worker.

7.141. Routine monitoring of internal exposure should be conducted on a fixed schedule for selected workers. […]

7.146. In order to determine the appropriate frequency and type of individual monitoring, the workplace exposure conditions should be characterized. The radionuclides in use and, if possible, their chemical and physical forms should be known. Consideration should also be given to the potential for these forms to change under accident conditions (e.g. the release of uranium hexafluoride into the atmosphere, resulting in the production of hydrogen fluoride gas and uranyl fluoride). The chemical form and physical form (e.g. particle size) of the material determine its behaviour in the respiratory tract and its subsequent biokinetic behaviour in the body. These in turn determine the excretion routes and rates, and hence the types of excretion sample that might need to be collected and their frequency of collection.

7.247. Situations may arise in which exposure due to hot particles is possible. This can lead to spatially non-uniform exposure from discrete radiation sources with dimensions of up to 1 mm. [...] Detection of hot particles within an ambient radiation field in a workplace can be difficult because of the very localized nature of the radiation from the particles. [...]

7.4. CONTROL OF OCCUPATIONAL EXPOSURE

7.4 (1) Issue: The plant does not systematically optimize radiation protection processes and controls to further reduce potential occupational exposure to as low as reasonably achievable level.

The team noted the following:

- There are 15 hot spots registered at the plant, varying from 400 microSv/h to 7000 microSv/h. There is no formal, integrated plan involving radiation protection, chemistry, operations, maintenance, and engineering departments to reduce the number of hot spots at the plant.
- The plant does not routinely use temporary shielding to reduce potential radiation exposure from hot spots. There is one set of lead blankets installed as temporary modification at one place for more than a year. There is no proposal for a design modification with permanent shielding, refitting piping, or other source term reduction solutions to remove the temporary shielding.
- The plant’s electronic personal dosimeter (EPD) can indicate both dose and dose rate alarms. In 2023, 77 EPD alarms were recorded (from approximately 90,000 RCA entries), out of which 36 were valid alarms and the remaining 41 were considered not valid, for several reasons. There were no valid total dose alarms in the period. Out of the real dose rate alarms 22 were above 1000 microSv/h and the highest value was 6150 microSv/h.
- EPD dose rate alarms (regardless of whether it is valid or not) do not require raising a condition report or another low level event report. Radiation protection performs an investigation of all alarms, but the information remains with radiation protection and the individual only and is reviewed at the station As Low As Reasonably Practical (ALARP) committee.
- During the review, it was observed that a Health Physicist and a Chemist checked a radiation monitor, the CO_2 monitor, and the ventilation system in the emergency control centre, however none of them identified that the status (white) light was not functioning.
- The team observed that during an exercise the radiation protection technicians were unable to correlate the activity concentration (Bq/m^3) with the committed dose rate (mSv/h) in the field outside the vehicle.
- At the pipe tunnel on Unit 7, local signage identified the contact dose rates and dose rates at a distance of 0.5 m, however it was dated to October 2022, while the survey frequency required by the procedure is every 6 months.
- At the exit of the Fuel Plugging Unit (FPU) C2 area, the radiation frisker was found defective.
- At the radioactive waste separation facility, a radiation protection worker coached the supervisor not to stay close to the wall, as the dose rates were higher at that location, however there was no sign indicating the area had increased radiation level.
- The plant does not display the detailed radiation and contamination levels inside the workplaces by signposting. Surveys are made, and sign posts are applied indicating dose rate ranges in general, like C0, C2, R2, R3, R4, which are area classification, not specific levels of dose rate and contamination.
- A sign for Elevated Dose Rate gave the dose rate information required on contact as +50 microSv/h and at 0.5 m as <50 microSv/h. The actual level of radiation above 50 microSv/h was not written.
- A posting at the Radiation Controlled Area entrance gave outdated information of radiography shot to happen on 6 September 2023 (observation was done on 9 October 2023).

– The team noted that there are cases when EPDs are not returned for days after the person leaves the RCA, and if it is detected by the radiation protection team they take the required action. However, a condition report is not raised. The EPD is the sole dosimeter used for official doses at the plant.

Without systematic optimization of radiation protection processes and comprehensive occupational exposure controls the plant may impact its capacity to further reduce potential occupational exposure to as low as reasonably achievable level at the plant.

Suggestion: The plant should consider optimizing radiation protection processes and occupational exposure controls.

IAEA Bases:

GSR Part 3

3.23. Registrants and licensees shall ensure that protection and safety is optimized.

3.24. […] registrants and licensees shall ensure that all relevant factors are taken into account in a coherent way in the optimization of protection and safety […]:
(a) To determine measures for protection and safety that are optimized for the prevailing circumstances, with account taken of the available options for protection and safety as well as the nature, likelihood and magnitude of exposures;
(b) To establish criteria, on the basis of the results of the optimization, for the restriction of the likelihood and magnitudes of exposures by means of measures for preventing accidents and for mitigating the consequences of those that do occur.

GSG-7

3.10. Optimization of protection and safety should be considered at all stages in the lifetime of equipment and installations, As a consequence, all situations — from design through operation to decommissioning and waste management — should be considered in the optimization procedure.

3.11. From a practical viewpoint, the requirements for optimization call for an approach that:
(a) Considers all possible actions involving the source(s) and the way workers operate with or near the source(s).
(b) Implies a ‘management by objective’ process with the following sequence: planning, setting objectives, monitoring, measuring performance, evaluating and analysing performance to define corrective actions, and setting new objectives.
[…]
(d) Encourages accountability, such that all parties adopt a responsible attitude to the process of eliminating unnecessary exposures.

3.16. […] The use of engineered controls should be examined carefully at this stage in defining the protection options. […] for example, where there is a potential for workers to receive a significant dose to the lens of the eye, attention should be paid to the installation of fixed shielding […] At this stage, the content and the scale of the optimization process will depend on the situation. […] For nuclear facilities, situations are more complicated, and a structured approach should be followed as part of the radiation protection programme, […]

8. CHEMISTRY

8.1. ORGANIZATION AND FUNCTIONS

The chemistry staff start their day with a morning meeting, where the actual plant status is described, and where the critical steps of the work planned for the day are identified. The staff report anomalies that present a risk and other low-level deviations that were experienced during the previous day. These reports are collected in a database and reviewed by the team twice a week in order to decide whether further action is required. This process drives the staff to look for deviations, safety issues, or process anomalies in the plant with a view to dealing with them before they become more significant. Preventing low level events from becoming significant enhances nuclear safety in the plant. The team identified this as a good performance in this area.

8.2 CHEMISTRY PROGRAMME

The objective of the chemistry programme is to preserve the integrity and availability of systems, structures and components. The plant has implemented chemistry regimes for each circuit according to the construction materials. Operating experience from other plants is included as relevant. However, the team found some control parameters to be in short or long term action levels, mainly due to leakages. The findings were included in the relevant issues in the areas of Maintenance and Technical Support.

To avoid detrimental effects of corrosion during longer shutdowns, systems, structures and components need to be preserved. The plant has developed preservation metrics that facilitates close monitoring of the status. The team identified this as a good practice.

The major discharges of radioactive liquid effluents from the radiation-controlled area are properly collected and controlled prior to discharge. In conformity with the license conditions, there are minor drains that are periodically sampled and analyzed, however, they are not collected and analyzed prior to release; these drains are pumped automatically to the sea. The team encouraged the plant to review this practice.

8.3. MANAGEMENT OF CHEMISTRY DATA

The plant uses several spreadsheets for calculating relevant quantities, e.g. the risk of stress corrosion cracking depending on chemical values. Such spreadsheets are either provided and approved by corporate or written and approved by the plant, but these were not write-protected to avoid unintended changes. The team encouraged the plant to improve the control of these spreadsheets.

8.6. QUALITY CONTROL OF OPERATIONAL CHEMICALS AND OTHER SUBSTANCES

The team observed Shortfalls in the standard for proper control and labelling of auxiliary chemicals and substances in the plant exist. For example, the plant policy for labelling of chemicals and substances does not indicate the area in which they are permitted to be used. The team found several unlabelled containers of chemicals in the plant, or containers that did not indicate the expiry date of the substance. The team provided a suggestion in this area.

DETAILED CHEMISTRY FINDINGS

8.2 CHEMISTRY PROGRAMME

8.2 (a) Good Practice: Chemistry Preservation Metric

To preserve the integrity of structures and components, it is necessary to maintain environmental conditions in systems removed from service during outages and long shutdowns. For the plant, these systems include the preheater, boiler, reheater, and auxiliary cooling systems. For proper preservation measures, several chemical parameters like humidity, hydrazine concentration, pH, and over pressure must be monitored and controlled. It is easy to lose organizational focus and understanding of system preservation status without a means to easily check status.

The plant has developed a metric that summarizes chemistry status as green, white, amber or red. The colour scheme allows the plant staff to quickly identify where further investigation is needed. The metric is included in the daily outage information and helps to focus on relevant action.

Communication of Indicator
09:00 Outage Meeting update item
Daily Outage Info - send update
to coordinator by 11am

Plant Preservation Indicator			100%
Green	White	Amber	Red

F&C	Rotaire to D/A Storage Vessel	1
	Rotaire to BFP Strainer A	1
	Rotaire to Generator	1
	Rotaire to condenser A	1
	Rotaire to condenser B	1
	Rotaire to condenser C	1
	Rotaire to Extr P/P	1
	Rotaire to TMEC NRV 271	1
	Score	1

Boilers	A Main boiler	1
	B Main boiler	1
	C Main boiler	1
	D Main boiler	1
	A DHB boiler	1
	B DHB boiler	1
	C DHB boiler	1
	D DHB boiler	1
	Score	1

A Reheater	Dry	1
	Days >plan no air	0
B Reheater	Dry	1
	Days >plan no air	0
C Reheater	Dry	1
	Days >plan no air	0
D Reheater	Dry	1
	Days >plan no air	0
	Total Dry	4
	Total days >plan	1
	Score	1

FAC	DP	1
	DP trend regen	1
	Score	1

MAC	Oxygen	1
	pH	1
	Score	1

		pH
Reactor Waters	A CACS	1
	B CACS	1
	C CACS	1
	D CACS	1
	PVCS Y1	1
	PVCS Y2	1
	DSSCS X1	1
	DSSCS X2	1
	BPGP	1
	Score	1

Feed & Condensate Dryers
1 represents dryer in service with no issues
0 represents dryer either in service with wet/cold air or out of service

Main Boiler and Decay Heat Dryers
1 represents dryer in service with no issues
0 represents dryer either in service with wet/cold air or out of service

Reheaters
1 represents that the boiler is dry
0 represents anything >30% rh
Days >7 self explanatory i.e. if air has been off to a reheater for 9 days then 2 days should be entered into cell for days 8 and 9

FAC
1 represents a good dew point and dew point trend
0 represents poor dp i.e. bypass might need adjustment and would also represent a fault with the dryer regeneration

MAC
For both Oxygen and pH
1 represents in specification chemistry
0.5 represents out of specification chemistry that is trendings towards exiting AL i.e. high oxygen but oxygen reducing
0 represents out of specification chemistry that is out of control i.e.unexplained air ingress

Reactor Waters
Outage reactor waters in specfication as per specification when pH elevated when no means of oxygen control
1 represents the system being in spec
0 represents pH/O2 being out of spec

Figure 8.1: Chemistry preservation metric

8.6. QUALITY CONTROL OF OPERATIONAL CHEMICALS AND OTHER SUBSTANCES

8.6 (1) Issue: Shortfalls in the standard for proper control and labelling of auxiliary chemicals and substances in the plant exist.

The team noted the following:

- The plant policy for labelling of chemicals and substances, does not include indication of where their use is permitted.
- In the radiological controlled area of reactor 7, in room RA7B2C01 outside 7A QUAD at -9 m, four 5-litre canisters of "CORROCOAT Chlor*RID DTS ®" ("causes skin irritation") and a 5-litre plastic container with red lid "PAL TECH" with "Cleaning and Degreasing Wipes" were found without labelling showing the permitted area to be used. Additionally, these were not stored in a bund or in a control of substances hazardous to health (COSHH) cabinet as required by the plant standard. 'The "PAL TECH" substance was not found in the appropriate plant chemical database, which is not according to plant expectation.
- In the radiological controlled area near door 99, one unlabelled 2.5-litre canister with an unknown oily liquid was found. This is not according to plant expectation.
- In the conventional laboratory, two empty 25-litre containers containing 'Trasar TM TRAC101' were found without labelling showing the permitted area to be used. This chemical is a corrosion inhibitor that used in a closed cooling water system.
- In the reactor building, one unlabelled chemical was observed on the platform of the refuelling machine. The plant explained that this is a degreaser and should have been properly labelled.
- Opposite to the main workshop, four barrels of "SHELL DIALA S4" were temporarily stored on a bench. Two of them were empty, two of them were full, and none were labelled showing the permitted area to be used.
- In the Unit 8 reactor building at refuelling level, there were four bottles of leak test spray found without labels showing the permitted area to be used.
- In the Jacobs storage cabinet, two tubes of "Silicone Grease RS 494-124" (100 ml) and one can "OMEGA 99N Nuclear Grade" without an expiry date were found. In the electrical workshop of the plant, three white 2.5-litre canisters were found, one of which was not labelled at all, another was poorly labelled and not according to plant procedure and the last was labelled according to plant procedure, however that label did not indicate the expiry date of the substance.

Without implementing a labelling standard and control of auxiliary chemicals clearly identifying which chemicals can be used where, detrimental effects on the integrity and availability of systems, structures and components could arise.

Suggestion: The plant should consider addressing shortfalls in the control and labelling standard for auxiliary chemical substances.

IAEA Bases:

SSR 2/2 (Rev. 1)

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

9. EMERGENCY PREPAREDNESS AND RESPONSE

9.2. EMERGENCY RESPONSE

The team identified that workers without a role in the emergency response organization are usually not trained in radiological response in anticipation they may be called upon during an emergency. As an example, the workers of the grid operator are not trained in radiological response or the use of a breathing apparatus. If specialist workers were required in an emergency, they would need to be trained just-in-time, however the plant does not have a plan or procedure for just-in-time training. The team encouraged the plant to improve in this area.

The team identified that the effective dose limit for emergency workers to take emergency response actions applied by the plant (100 mSv) is not in compliance with IAEA Safety Standards, which specify the effective dose limit for an emergency worker taking life-saving actions and avoiding severe consequences as 50 mSv. The plant indicated that their effective dose limit is in compliance with the UK national regulations. The team made a recommendation in this area.

9.3. EMERGENCY PREPAREDNESS

A digital system was used in the plant that allows direct sharing of whiteboard content across all emergency response facilities. The system includes a conventional whiteboard and a stem mounted camera. The camera detects changes in the content of the whiteboard and saves a timestamped snapshot of the whiteboard in a timeline ribbon that can be accessed remotely from the various response facilities. The team recognized this as a good practice.

The plant adopted a method of briefing off-site emergency services during emergency situations using the ‘METHANE’ mnemonic. METHANE represents a standard way to share important information about an incident in a clear and consistent fashion. The team recognized this as a good practice.

The team identified that the training and exercise programme requirements do not ensure that the proficiencies of all staff in each emergency response position is maintained. A large proportion of the training to qualify for various roles in the emergency response organization (ERO) is valid for fifty-one years. The plant relies on attendance at an emergency exercise as a minimum every three years to ensure that competencies are retained for all members of the ERO, however the plant does not keep a record of which essential competencies for emergency roles are tested during each exercise. The team made a suggestion in this area.

The exercise programme does not systematically evaluate implementation of all functions of the emergency response organization. The plant does not keep track of the objectives corresponding to functional response areas of the emergency plan covered by each exercise and does not ensure that all such objectives are covered over a period of time, in order to systematically evaluate their implementation. The team made a suggestion in this area.

DETAILED EMERGENCY PREPAREDNESS AND RESPONSE FINDINGS

9.2 EMERGENCY RESPONSE

9.2 (1) Issue: The effective dose limit and controls applied by the plant for emergency workers to take emergency response actions is not aligned with the IAEA Safety Standards.

According to the Emergency Handbook of the plant, workers are authorized for emergency exposure to exceed the limits specified in national regulations for occupational exposure (20 mSv/y) in emergency situations. Priority must be given to reducing doses below an effective dose of 100 mSv, but in extremely severe accidents involving saving of life, or when preventing a major release of radioactivity, the Emergency Controller may authorize identified emergency workers to exceed 100 mSv, but not to exceed 500 mSv. The actions decided and the names of the volunteers must be recorded in the emergency logs and volunteers must be made aware of the significance of the risk associated with the doses for which they have volunteered.

However, the team noted:

- The effective dose limit applied by the plant (100 mSv) is not in compliance with IAEA Safety Standards which specify the effective dose limit for an emergency worker taking lifesaving actions and avoiding severe consequences as 50 mSv. The plant indicated that their effective dose limit is in compliance with the UK national regulations (REPPIR 20.(1) and REPPIR 18.(8)).
- Emergency workers receive their briefing on risk via an Access Control Point (ACP) briefing process. However, the process does not explicitly cover clear and comprehensive information of the health risks associated with the dose turnback limit and a formal acknowledgement that the worker accepts the risk.

Without applying a strict effective dose limit and controls for taking lifesaving actions and avoiding severe consequences, the protection of the emergency workers may not be optimal.

Recommendation: The plant should update the emergency effective dose controls and change the limit to 50 mSv.

IAEA Bases:

GSR Part 7

5.55. The operating organization and response organizations shall ensure that no emergency worker is subject to an exposure in an emergency that could give rise to an effective dose in excess of 50 mSv other than:
(1) For the purposes of saving human life or preventing serious injury;
(2) When taking actions to prevent severe deterministic effects
or actions to prevent the development of catastrophic conditions that could significantly affect people and the environment;
(3) When taking actions to avert a large collective dose.

5.57. The operating organization and response organizations shall ensure that emergency workers who undertake emergency response actions in which doses received might exceed an effective dose of 50 mSv do so voluntarily.
GSR Part 3

4.15. Response organizations and employers shall ensure that no emergency worker is subject to an exposure in an emergency in excess of 50 mSv other than:
(a) For the purposes of saving life or preventing serious injury;
(b) When undertaking actions to prevent severe deterministic effects and actions to prevent the development of catastrophic conditions that could significantly affect people and the environment; or
(c) When undertaking actions to avert a large collective dose

4.17. Response organizations and employers shall ensure that emergency workers who undertake actions in which the doses received might exceed 50 mSv do so voluntarily.

9.3 EMERGENCY PREPAREDNESS

9.3 (a) Good practice: Live White Board Sharing Approach

A digital system was used in the plant that allows direct sharing of whiteboard content across all facilities. The system includes a conventional whiteboard and a stem mounted camera. The camera detects changes in the content of the whiteboard and saves a timestamped snapshot of the whiteboard in a timeline ribbon that can be accessed remotely from the various emergency response facilities.

Previous whiteboards allowed for local printing of hardcopies but had no sharing capability. Web cameras pointed at whiteboards have been used in the past to share the content of the whiteboards across facilities, but they did not allow for electronic 'time-stamp' records to be maintained. Screen captures of the video feed could be printed, but the hardcopies were of low quality due to the limitations of the technology. Smart boards can share information, but they require special pens and are more difficult to use.

The Live White Board Sharing Approach is simple to use, enhances the usefulness of the status boards, and provides a record of the information posted during an emergency.

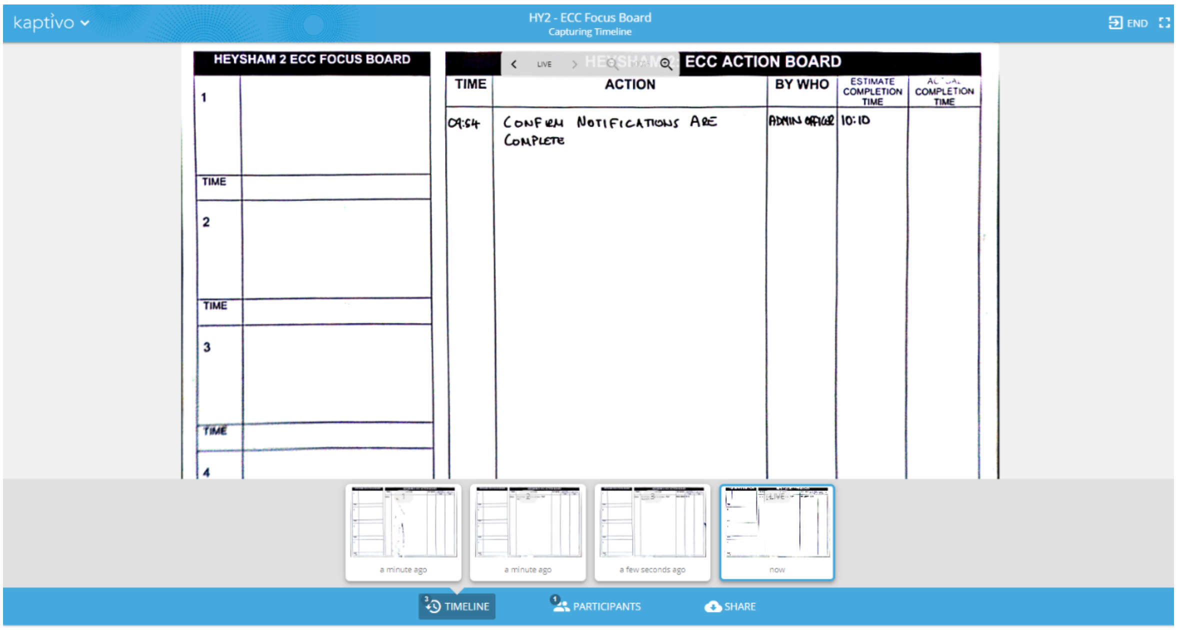

Figure 9.1: Live White Boarding Sharing

9.3 (b) Good practice: METHANE emergency briefing mnemonic

The plant adopted a method of briefing off-site personnel during emergencies using the ‘METHANE’ mnemonic. METHANE represents a standard way to share important information about an incident in a clear and consistent way.

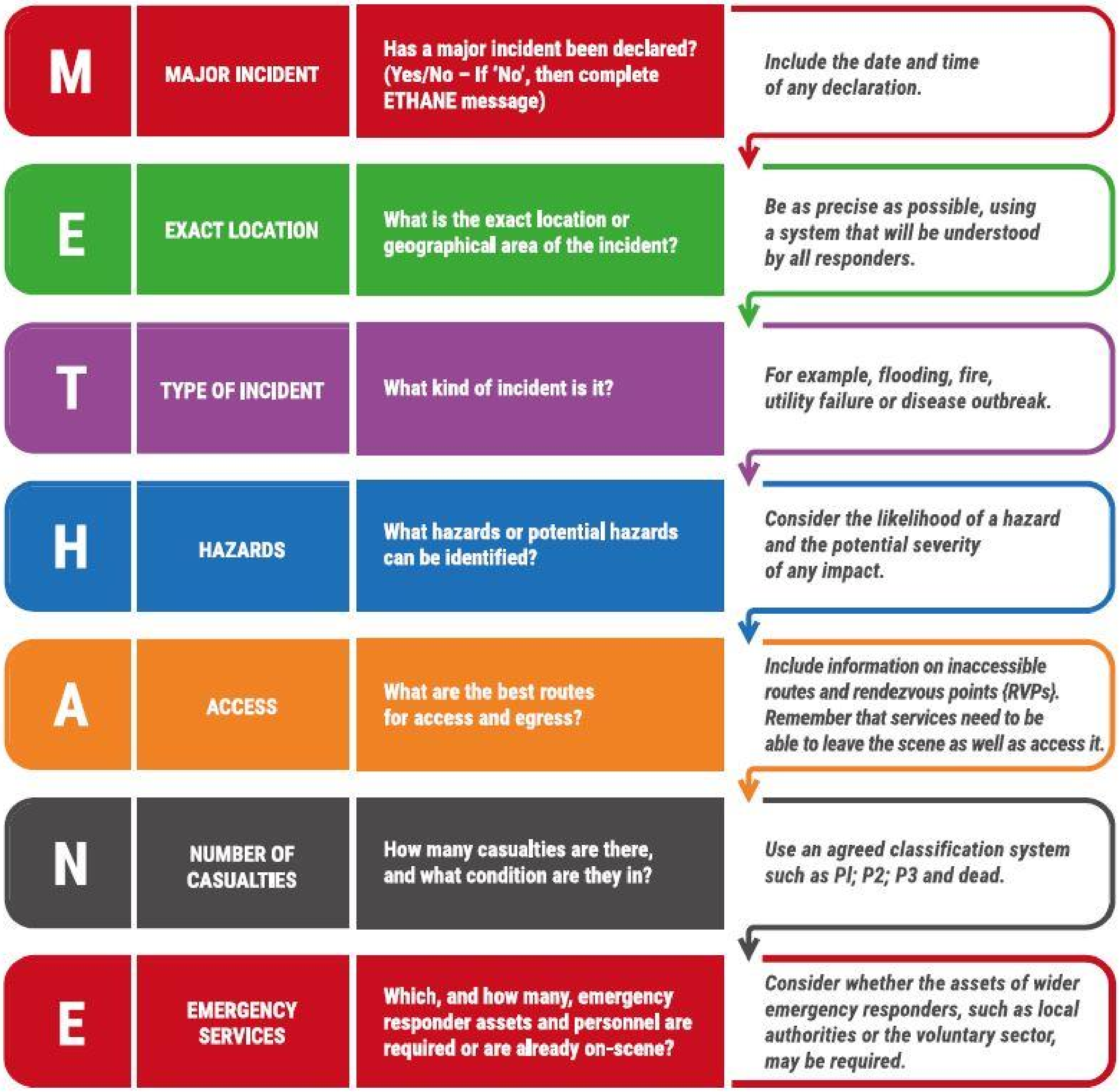

Figure 9.2: METHANE method details

The process aligns with the UK Emergency Services Joint Emergency Services Inter-Operability Principles (JESSIP) and ensures sharing situational awareness across the EDF and the local authority emergency response throughout an event.

The METHANE report should not be used just once. It is the standard format for passing information about an incident. This will make sure that all agencies get the information they need. It will also act as a trigger if an incident condition deteriorates over time.

9.3 (1) Issue: The training and exercise programme requirements do not ensure that the proficiencies of staff in each emergency response position are maintained.

The team noted the following:

- A large proportion of the training to qualify for various roles in the emergency response organization is valid for fifty-one years. Only a few training courses require refresher training repeated annually, eighteen monthly, or every three years.
- The plant relies on attendance at an emergency exercise as a minimum every three years to ensure that competencies are retained for all members of the emergency response organization, however the plant does not keep a record of which essential competencies for emergency roles are tested during each exercise for each individual. As a result, the plant cannot prove that all competencies have been tested and retained by all emergency response staff.
- There are seven persons qualified as Emergency Controllers. There are typically five shift crew exercises, plus two or three more demonstration exercises per year on a given theme. In recent years, some Emergency Controllers have participated in more than one exercise in the same calendar year. This means that some qualified persons have not performed in an Emergency Controller role during an annual exercise for more than 12 months.
- The plant has five essential roles in the emergency response organization. For these roles, the plant requirement is to have a minimum of four persons qualified and the plant target is to have six persons qualified. In 2021-2022, there were five qualified assistant Emergency Controllers and four Accredited Health Physicists. In order to qualify new persons for a given role, the plant required them to participate in exercises on an accelerated schedule. As a result, other qualified incumbents for these roles did not have as many opportunities to participate in a refresher exercise.

Without ensuring that each member of the emergency response organization is regularly trained and participates in exercises testing all the essential competencies, their proficiency to effectively respond in an emergency cannot be maintained.

Suggestion: The plant should consider improving regular training and exercises requirements for each member of the emergency response organization to ensure that proficiencies are maintained.

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.

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

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3.10. The operating organization shall be responsible for ensuring that the necessary knowledge, skills, attitudes and safety expertise are sustained at the plant, and that long term objectives for human resources policy are developed and are met.

3.11. The organization, qualifications and number of operating personnel shall be adequate for the safe and reliable operation of the plant in all operational states and in accident conditions. Succession planning shall be an established practice for the operating personnel. The recruitment and selection policy of the operating organization shall be directed at retaining competent personnel to cover all aspects of safe operation. A long term staffing plan aligned to the long term objectives of the operating organization shall be developed in anticipation of the future needs of the operating organization for personnel and skills.

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.

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4.34. The purpose of exercises and drills should be as follows:

a) To demonstrate how effectively the emergency plan (see Requirement 18 of SSR-2/2 (Rev. 1) [1]), or part of the emergency plan, can be implemented;
b) To confirm the adequacy of the plan to deal with an emergency and to identify potential improvements;
c) To verify that the appropriate lines of communication are established and maintained;
d) To verify that all participating individuals are familiar with, and capable of performing, the emergency duties assigned to them;
e) To verify that emergency response duties and all related duties can be performed under stressful conditions in a timely manner and in accordance with the expected schedule;
f) To verify the provisions for the assessment of radiological hazards and the implementation of protective actions.

9.3 (2) Issue: The exercise programme does not systematically evaluate implementation of all functions of the emergency response organization.

The team noted the following:

- The plant keeps track of exercise frequencies covering themes (conventional, BDBA, and off-site security) and variants (during working hours or outside working hours, rooms or facilities where intervention is required, etc.) to ensure that the exercises are varied. However, the plant does not keep track of the specific objectives corresponding to functional response areas of the emergency plan covered by each exercise and hence does not ensure that all such objectives are covered over a period of time.
- Some of the evaluation reports of the exercises include a qualitative evaluation of the exercise objectives. The plant lists what went well and what could be improved, but these observations are not summarized in a systematic evaluation of how the exercise objectives were met with clear criteria.
- In 2022, exercise Hercules identified 9 objectives and key performance indicators. The evaluation report included a qualitative evaluation of 5 of them, without providing the criteria that supported the evaluation.
- In 2021, exercise Ragnarok identified 16 objectives and key performance indicators. The evaluation report included a qualitative evaluation of 9 of them, without providing the criteria that supported the evaluation.

Without systematically evaluating all functions of the emergency response organization during exercises, the plant cannot ensure that they can be effectively implemented during an emergency.

Suggestion: The plant should consider systematically evaluating the implementation of all functions of the response organization during exercises.

IAEA Bases:

GSR Part 7

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.

EPR-Exercise

4.1. The most recent IAEA guidance for emergency response objectives is EPR-Method [2]. This document provides checklists of emergency preparedness elements and emergency response functions that cover nuclear as well as radiological emergencies (threat categories I to V). Each emergency response function is defined in terms of a main response objective and, where appropriate, by a performance objective.

7.3.5. A performance-based evaluation focuses on results, not process. It is based on response objectives and response time objectives (see Appendix X of [2] for details). It answers the question: was the response objective achieved and in what time it was achieved?

10. ACCIDENT MANAGEMENT

10.1. ORGANIZATION AND FUNCTIONS

The Accident Management Training and Qualification Programme is not comprehensive to ensure that personnel are fully prepared to support Severe Accident Guideline (SAG) implementation. The team identified that the Emergency Controller who is the primary decision maker for SAGs is not required by the programme to receive formal SAG training and is not required to participate in a drill/exercise involving SAGs as part of their initial qualification. The team also identified that continuing training requirements are not established for key roles supporting SAG implementation and that evaluation criteria have not been established to assess the effective utilization of SAGs in training drills/scenarios. The team made a recommendation in this area.

The team performed a review of accident management programme training materials and noted that roles and responsibilities of Decision Makers and Evaluators in both the preventative and mitigative domains are not fully clarified. The team encouraged the plant to enhance training materials to further clarify roles and responsibilities.

10.4 DEVELOPMENT OF PROCEDURES AND GUIDELINES

Guidance for the preparation and review of SAGs and the control of staged equipment is not comprehensive to ensure that these activities are conducted in a manner that supports programme goals. The team identified that the SAG Guidance Document does not clarify the standards for validation activities and the periodic review of SAGs is only performed as part of the 10-year PSR process. Equipment is staged in the plant to support response to a Beyond Design Bases Event (BDBE), however, the team identified that Foreign Material Exclusion (FME) covers are not always installed on hose and electrical connections, signage is not provided to ensure that personnel do not remove staged equipment without authorization, inventory of staged equipment is not performed, and measures such as checks on operator rounds are not established to ensure that workers do not block access to connection points or routes used to deploy portable equipment. The team made a suggestion in this area.

10.5. PLANT EMERGENCY ARRANGEMENTS WITH RESPECT TO SAM

Additional hardware provisions have been provided to ensure that indications used to assess plant conditions remain functional after a Beyond Design Basis (BDB) event. Following a BDB event causing loss of normal indications, the Continuous Emergency Monitoring System (CEMS) provides a live display of key plant parameters in multiple locations both on and off-site to facilitate severe accident management decision making. CEMS records 8 hours of plant data leading up to and 24 hours after the event utilizing resilient power supplies. CEMS also provides an interface to the Deployable Communication and Information System (DCIS) so that plant status can continue to be monitored beyond the initial 24-hour period that CEMS supports. The team recognized this as a good practice.

Deployable Back Up Emergency Equipment (DBUE) to support a BDB event is located at an off-site location which requires transport to the plant. The equipment would be transported by an on-call team of drivers who have the capability to move all the required equipment to a designated staging area regardless of time and environmental conditions. Driver availability is monitored and tracked real time via GPS and reported on every two hours. This arrangement ensures that DBUE deployment to the plant can commence within two hours of notification. Comprised of some 220 drivers, the national driver cohort which supports the activation system undergoes annual refresher training in deployment to maintain proficiency and capability. The team recognized this as a good performance.

DETAILED ACCIDENT MANAGEMENT FINDINGS

10.1 ORGANIZATION AND FUNCTIONS

10.1 (1) Issue: The Accident Management Training and Qualification Programme established by corporate and used at the plant is not comprehensive to ensure that personnel are fully prepared to support Severe Accident Guideline (SAG) implementation.

The team noted the following:

- The Emergency Controller (EC) is the Primary Decision Maker during the implementation of SAGs. However, the corporate Generic Emergency Scheme Training (GEST) Training Role Matrix does not require the EC to receive SAG Training.
- While not required by corporate, some plant ECs have received SAG training, however the two most recently qualified ECs have not received SAG training.
- The training programme does not require participation of ECs in a drill/exercise involving SAGs as part of their initial qualification.
- The use of SAGs requires extensive input and technical support from the corporate Central Emergency Support Centre (CESC). However, the CESC is not required to be involved (directly or simulated manner) in training drills/exercises that would involve SAG utilization for the plant.
- Continuing training requirements are not established for key roles supporting SAG implementation such as the EC and the Duty Reactor Physicist.
- Evaluation criteria have not been established to assess the effective utilization of SAGs in training drills/scenarios.
- The plant prepared a plan to address issues related to the conduct of drills/exercises involving the use of SAG noted in an external review. Based on the plan, drills/exercises have started on the Symptom Based Emergency Response Guidelines (SBERGs) and future drills/exercises are planned on the SAGs. However, requirements for drills/exercises have not yet been integrated into the corporate and plant accident management programmes to ensure long-term sustainable performance.

Without comprehensive training and qualification, the ability and proficiency of the plant staff to respond to a severe accident could be challenged.

Recommendation: The plant should improve the Accident Management Training and Qualification Program to ensure that plant staff is prepared to support SAG implementation.

IAEA Bases:

SSR-2/2 (Rev.1)

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

5.9. Arrangements for accident management shall provide the operating staff with appropriate competence, systems and technical support. These arrangements and relevant guidance shall be available before the commencement of fuel loading, shall be validated and shall then be periodically tested as far as practicable in exercises and used in training and drills [1, 6]. In addition, arrangements shall be made, as part of the accident management programme and the emergency plan, to expand the emergency arrangements, where necessary, to include the responsibility for long term actions.

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2.98. Personnel responsible for performing accident management measures should be trained to acquire the required knowledge, skills and proficiency to execute their tasks. A comprehensive training programme for accident management should be prepared that includes the interfaces with emergency preparedness and response. Training should include a combination of techniques, such as classroom training, drills, tabletop exercises and the use of simulation tools.

2.103. Training, including periodic exercises and drills, should be sufficiently realistic and challenging to prepare personnel responsible for accident management duties to cope with and respond to situations that may occur during an event [21]. Drills should extend over a time period long enough to realistically represent the plant response and should allow for the transmission of information during shift changes to be tested. Special exercises and drills should be developed to practice shift changeovers between operations staff and technical support centre staff and information transfer between different teams. Training should cover accidents occurring simultaneously at more than one unit, accidents occurring in different reactor operating states and accidents in the spent fuel pool. Training should consider unconventional line-ups of the plant equipment, the use of non-permanent equipment (e.g. diesel power generators, pumps) and repair of the equipment.

2.105. Training for new staff, as well as refresher training for existing staff, should be developed for all groups of staff involved in accident management. The frequency of refresher training should be established on the basis of the difficulty and the importance of accident management tasks. A maximum interval for refresher training should be defined, but depending on the outcome of exercises and drills held at the plant, a shorter interval may be selected. Changes in the guidance or in the use of the guidance should be reflected in the training programme. Such changes should be communicated to interested parties.

3.114. Training, including periodic exercises and drills, should be sufficiently realistic and challenging to prepare personnel responsible for severe accident management duties to cope with and respond to situations that may occur during an event. Drills should extend over a time period long enough to realistically represent the plan response and should allow for the transmission of information during shift changes to be tested. Special exercises and drills should be developed to practice shift changeovers between operations staff and technical support centre staff and information transfer between different teams. Training should cover severe accidents occurring simultaneously at more than one unit and severe accidents occurring in different reactor operating states. Training should consider unconventional line-ups of the plant equipment, the use of non-permanent equipment (e.g. diesel power generators, pumps) and repair of the equipment.

3.115. Exercises and drills should be based on scenarios that require the application of a substantial portion of the overall severe accident management programme in concert with emergency response and should simulate realistic conditions characteristic of those that would be encountered in an emergency. Large scale exercises providing an opportunity to observe and evaluate all aspects of severe accident management should be undertaken.

3.117. Some of the scenarios used for exercises and drills should assume an extensively damaged state of the core that eventually results in failure of the reactor pressure vessel and the containment. Consideration should be given to conducting exercises that enhance the awareness of main control room staff, technical support centre staff and engineering staff of the need for and possible consequences of defeating or resetting control and logic systems.

10.4. DEVELOPMENT OF PROCEDURES AND GUIDELINES

10.4 (1) Issue: Guidance for the preparation and review of SAGs and the control of staged equipment which support Deployable Backup Equipment (DBUE) use is not comprehensive to ensure that these activities are conducted in a manner that effectively supports programme goals.

The team noted the following:

- The corporate SAG Guidance Document does not distinguish the differences between SAG verification and validation activities. Standards for validation have not been established in the document although some aspects of validation were stated as having been performed.
- Plant guidelines for the periodic review of procedures do not require periodic review of the SBERGs. Corporate guidelines for the periodic review of procedures do not require the periodic review of SAGs. The SAGs are reviewed as part of the 10-year PSR process.
- Foreign material exclusion (FME) covers are not installed on hoses and electrical plug connections for Deployable Backup Equipment staged in the plant.
- Signage is not provided to ensure that personnel do not remove staged equipment without authorization.
- Measures are not established such as periodic field operator reviews of connection points and staged material to ensure that workers do not block access to DBUE connection points or routes or compromise staged equipment. This concern would be magnified during outage periods that involve many field work activities and large numbers of contract workers.
- There is no guidance to perform a periodic inventory of some staged equipment to ensure that it is available.
- The completed Accident Management Self-Assessments were found primarily compliance-based and reactive versus a proactive critical review of programme effectiveness and did not utilize external peers to provide outside perspectives.

Without comprehensive guidance for the preparation and review of SAGs and the control of staged equipment, the readiness of the plant to manage a severe accident could be compromised.

Suggestion: The plant should consider improving the guidance for preparation and review of SAGs and controls for staged equipment to ensure availability.

IAEA Bases:

SSR-2/2 (Rev.1)

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

5.8. An accident management programme shall be established that covers the preparatory measures, procedures and guidelines, and equipment that are necessary for preventing the progression of accidents, including accidents more severe than design basis accidents, and for mitigating their consequences if they do occur. The accident management programme shall be documented and shall be periodically reviewed and as necessary revised.

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2.56. Verification and validation processes should assess the technical accuracy and adequacy of the accident management guidance to the extent possible, as well as the ability of personnel to follow and implement this guidance. The verification process should confirm the compatibility of the guidance with the referenced equipment, user aids and supplies (e.g. non-permanent equipment, posted job aids, computational aids) (see Ref. [17]). The validation process should demonstrate that the necessary instructions are provided to implement the guidance.

2.57. The staff involved in the validation of accident management guidance should be different from those who developed the guidance. Developers and writers of plant specific accident management guidance should prepare appropriate tests and scenarios for validation, and their participation as observers to the validation process may be beneficial (see Ref. [18]).

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

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

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

3.64. Possible methods for the validation of the SAMGs and background documents include:
(a) an engineering simulator including a full scope simulator (if available) or other plant analysis tool, and
(b) a tabletop method. The most appropriate method or combination of methods should be selected, taking into account the role of each functional group of personnel in an emergency.

3.65. If a full scope simulator is used, validation should encompass the uncertainties in the magnitude and timing of phenomena (both phenomena that result from the accident progression and phenomena that result from recovery actions). Consideration should be given to simulating a degraded or unavailable instrumentation response, or a delay in obtaining the information.

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.

3.90. When the severe accident management strategies rely on non-permanent equipment, the operability of such equipment for anticipated conditions and for the actual configuration and layout should be assessed to confirm that it is likely to meet accident management objectives. Steps should be taken (including obtaining any necessary permits or licenses) to ensure that personnel can install and operate the non-permanent equipment within the time frames necessary even under adverse conditions.

10.5 PLANT EMERGENCY ARRANGEMENTS WITH RESPECT TO SAM

10.5 (a) Good Practice: Monitoring of Key Plant Parameters Following a BDB Accident

Following a Beyond Design Basis (BDB) event causing loss of normal indications, the Continuous Emergency Monitoring System (CEMS) provides live display of key plant parameters in multiple locations both on and off-site to facilitate severe accident management decision making. CEMS records 8 hours of plant data leading up to and 24 hours after the event utilizing resilient station-based power. It consists of permanently installed response equipment and, when deployed, the CEMS Repair Kit can replace the functionality of key station-based system components. CEMS also provides an interface to the Deployable Communication and Information System (DCIS) so that plant status can continue to be monitored beyond the initial 24-hour period that CEMS supports.

The CEMS cubicle acts as the central hub of the CEMS system capturing data and making it available for users (CCR, Reactor Building, ECC) to view or download locally or from remote locations. A single CEMS cubicle is capable of monitoring two reactors. If the site is required to be evacuated, a mobile command centre is established at an appropriate staging post and the system can transmit data to this command centre, the CESC, and other organizations as required. Parameters provided to monitor Critical Safety Functions (CSFs):
- Reactor bottom temp, T1 (2 Quadrants) - Circulator Outlet Gas Temp;
- Reactor top temp, T2 (2 Quadrants) - T2 Temperature;
- Reactor Pressure - Reactor Gas Pressure;
- Boiler Conditions - Boiler Outlet Pressure (4 Quadrants).

Key Benefits Provided by CEMS:
- Permits transfer of parameters key to monitor critical safety functions in a BDB event;
- Permanently installed in the plant;
- Continuously monitoring to record an additional 8 hours of data preceding the event;
- Provides parameters for 24 hours independently, which can be extended by DCIS from DBUE;
- Provides indications to multiple locations for flexibility:
  - Fixed PC in the Emergency Control Centre (ECC);
  - Satellite PC stored on site to allow mobile access;
  - Interfaces with the DCIS supplied as part of the DBUE;
  - Can transmit data to mobile and fixed offsite Command and Control locations;

Accessible by the Corporate Central Emergency Support Centre (CESC) for support.

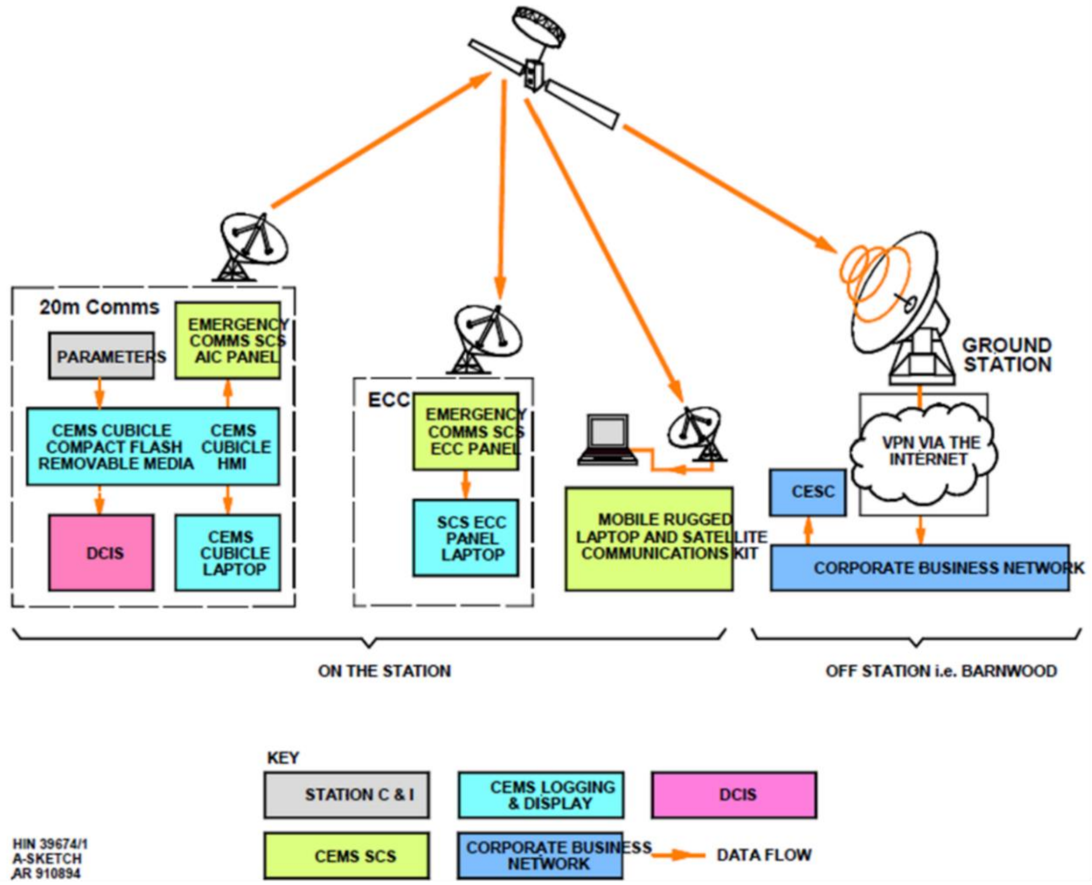

Figure 10.1. Representation of the Continuous Emergency Monitoring System

DEFINITIONS

Recommendation

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

Suggestion

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

Good practice

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

Good performance

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

Self-identified issue

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

Encouragement

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

REFERENCES

Safety Fundamentals (SF)

- **SF-1**; Fundamental Safety Principles (Safety Fundamentals)

General Safety Requirements (GSR)

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

Specific Safety Requirements (SSR)

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

General Safety Guides (GSG)

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

Safety Guides (SG)

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

Specific Safety Guides (SSG)

- **SSG-2 Rev.1**; Deterministic Safety Analysis for Nuclear Power Plants

- **SSG-3**; Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants
- **SSG-4**; Development and Application of Level 2 Probabilistic Safety Assessment for Nuclear Power Plants
- **SSG-13**; Chemistry Programme for Water Cooled Nuclear Power Plants
- **SSG-25**; Periodic Safety Review for Nuclear Power Plants
- **SSG-28**; Commissioning for Nuclear Power Plants
- **SSG-38**; Construction for Nuclear Installations
- **SSG-39**; Design of Instrumentation and Control Systems for Nuclear Power Plants
- **SSG-40**; Predisposal Management of Radioactive Waste from Nuclear Power Plants and Research Reactors
- **SSG-47**; Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities
- **SSG-48**; Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants
- **SSG-50**; Operating Experience Feedback for Nuclear Installations
- **SSG-54**; Accident Management Programmes for Nuclear Power Plants
- **SSG-61**; Format and Content of the Safety Analysis report for Nuclear Power Plants
- **SSG-70**; Operational Limits and Conditions and Operating Procedures for Nuclear Plants
- **SSG-71**; Modifications to Nuclear Power Plants
- **SSG-72**; The Operating Organization for Nuclear Power Plants
- **SSG-73**; Core Management and Fuel Handling for Nuclear Power Plants
- **SSG-74**; Maintenance, Testing, Surveillance and Inspection in Nuclear Power Plants
- **SSG-75**; Recruitment, Qualification and Training of Personnel for Nuclear Power Plants
- **SSG-76**; Conduct of Operations at Nuclear Power Plants
- **SSG-77**; Protection against Internal and External Hazards in the Operation of Nuclear Power Plants

International Labour Office publications on industrial safety

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

- Safety and health in construction, International Labour office (ILO), Geneva, ISBN 92-2-107104-9
- Safety in the use of chemicals at work, International Labour office (ILO), Geneva, ISBN 92-2-108006-4

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