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# REPORT

## of the

# OPERATIONAL SAFETY REVIEW TEAM (OSART)

## MISSION

## to

# Sizewell B

# NUCLEAR POWER STATION

## 5 – 22 October 2015

DIVISION OF NUCLEAR INSTALLATION SAFETY
OPERATIONAL SAFETY REVIEW MISSION
IAEA-NSNI/OSART/15/185

## PREAMBLE

This report presents the results of the IAEA Operational Safety Review Team (OSART) review of Sizewell B Nuclear Power Station, United Kingdom. It includes recommendations 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.

## 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 Sizewell B Nuclear Power Station from 5 to 22 October 2015. The purpose of the mission was to review operating practices in the areas of Leadership and management for safety; Training & qualification; Operations; Maintenance; Technical support; Operating experience feedback; Radiation protection; Chemistry; Emergency preparedness and response; and Accident management. In addition, an exchange of technical experience and knowledge took place between the experts and their station counterparts on how the common goal of excellence in operational safety could be further pursued.

Sizewell B Nuclear Power Station is located on the North Sea coast approximately 100 miles (160 km) North-East of London. Sizewell B is the UK's only commercial pressurized water reactor (PWR) power station, with a single reactor and rated capacity 1198 MWe (net). The "nuclear island" at Sizewell B is based on a Westinghouse "4-loop" plant known as SNUPPS (Standard Nuclear Unit Power Plant System). Sizewell B uses two full-speed, 3,000 RPM (50 Hz), nominal 660 MW turbo-alternator sets. It was built and commissioned between 1988 and 1995, first synchronized with the national grid on 14th February 1995. The power station is operated by EDF-Energy.

The Sizewell B OSART mission was the 185th in the OSART programme, which began in 1982. The team was composed of experts from Brazil, Canada, France, Germany, the Russian Federation, South Africa, the United States of America and the IAEA staff members. The collective nuclear power experience of the team was approximately 390 years.

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

Throughout the review, the exchange of information between the OSART experts and station 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 station's performance compared with the IAEA Safety Standards.

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

## MAIN CONCLUSIONS

The OSART team concluded that the managers of Sizewell B NPS are committed to improving the operational safety and reliability of their station. The team found good areas of performance, including the following:

- Accelerated pace Nuclear Leadership Programme (NLP) with Inclusion Workshops to train current and emerging leaders on important nuclear leadership principles and behaviour.
- The station's Periodic Safety Review (PSR2) process which is comprehensive and rigorous and based on benchmarking with wide range of modern safety standards.
- A single organizational Learning Portal enabling an easy collection and access to internal and external operational experience throughout all station departments.
- A well developed and documented process to ensure that the emergency exercises comprehensively cover the situations that could arise during emergencies.

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

- The station should enhance its policy and practices for handling and use of operating procedures and operator aids to ensure that current and correct documents are always available for use by operators.
- The station should improve the implementation of its foreign material exclusion (FME) programme.
- The station should enhance its corrective action programme trending so that adverse trends are identified and corrected in a consistent and timely manner.
- The station should continue its programme of reviewing and updating severe accident management procedures across all plant areas and conditions, incorporating experience from the 2011 Fukushima accident.

Sizewell B management expressed a determination to address the areas identified for improvement and indicated a willingness to accept a follow up visit in about eighteen months.

# 1. LEADERSHIP AND MANAGEMENT FOR SAFETY

## 1.1. LEADERSHIP FOR SAFETY

Current and emerging leaders were trained on important nuclear leadership principles and behaviours using the detailed and comprehensive Nuclear Leadership Programme. 136 leaders were trained in the space of 2 years. In addition, the station realized that the success of the Nuclear Leadership Programme could be maximized if some workers participated in Inclusion Workshops. A total of 134 workers have participated in these Inclusion Workshops. Leadership principles have been summarized in a model based on international standards of excellence. This model, called “behaviours for success” targets improved performance through behavioural changes. This model is promoted, deployed and used across the whole station. The team considers that the combination of Leadership training with the “behaviours for success” model as a good practice.

Although the station has had continuously improving records in safety and reliability for 3 consecutive years, during the mission the team observed deficiencies with the implementation of proactive measures to increase safety and reliability in the near and long term. Shortfalls were identified in three areas: adverse record/trending and recurrent issues, transition planning, and competencies and staffing. The team suggests the station continues implementing proactive measures to increase performance in the near and long term in order to continuously improve safety and reliability performance.

## 1.3. NON-RADIATION-RELATED SAFETY PROGRAMME

The station has a double Red / Green Line Policy to demarcate zones where essential Personal Protective Equipment (PPE) must be worn. The welfare and office zones of the site lie on the Green side while the operation and industrial zones are on the Red side of the site. The Red/Green Line policy helps make it clear where PPE must be worn. As a result of the clarity of the Red/Green policy, there is a good compliance by workers, which helps minimize the risk of injury. The team considers this to be good performance.

## 1.4. DOCUMENT AND RECORDS MANAGEMENT

The team observed deficiencies with respect to documentation control and use of uncontrolled documents. Shortfalls have been identified in different areas: corporate procedures applying to the station, Operations’ documentation, emergency preparedness documentation, RP documentation. Moreover, events involving documentation issues were also identified. The team suggests the station improves its documentation policy and control to ensure that station documents are always controlled in a consistent and compatible manner.

## 1.9. SAFETY CULTURE

A strong safety culture is composed of many attributes that collectively demonstrate the approach to promoting a safe working environment within an organization. During the review period the overall experience of the team is utilized to capture those behaviours, attitudes and practices that characterise the safety culture in place at the station. The team identified a number of facts related to strengths and weaknesses in performance that may affect safety culture that could assist the ongoing management efforts to improve safety culture at the station.

With respect to observed strengths, the team identified that the station staff has demonstrated a strong commitment to safety at the station. Questioning attitude, no hesitancy to raise concerns, evidence that individuals understand the importance for adherence to high nuclear safety standards, demonstrated high professional proficiency were some of the behavioural features supporting continuous identification of safety improvement opportunities.

The station holds short meetings to deliver the daily "Safety message and station status brief" prior to any activities on the site and thus ensure continuous staff safety awareness.

The staff proactive involvement in the discussions on these daily messages was considered by the team as a good practice.

There are other attributes that the team believes could be strengthened to improve the overall safety culture and safety performance at the station. The team noted that the management involvement in coaching during station field tours could be improved, and the station approach to analysing equipment reliability trends could be more proactive to ensure prevention of equipment failure or other operational events. The team also observed some cases of station deficiencies in the field not being promptly identified and reported, for example deficiencies relating to implementation of FME practices.

## DETAILED LEADERSHIP AND MANAGEMENT FOR SAFETY FINDINGS

### 1.1. LEADERSHIP FOR SAFETY

**1.1(a) Good practice:** Accelerated pace Nuclear Leadership Programme (NLP) with Inclusion Workshops for employees.

A detailed and comprehensive Nuclear Leadership Programme trained current and emerging leaders on important nuclear leadership principles and behaviours. The Management Team went through the leadership programme first to ensure the tone was set and behaviours and knowledge were role modelled. The accelerated programme trained 136 leaders in the space of 2 years.

The station realized that the success of the Nuclear Leadership Programme could be maximized if some workers participated in Inclusion Workshops, where they were exposed to key modules of the programme. The workshops enhanced cross-functional working and minimised “departmental silo” attitudes. A total of 134 workers have now participated in these Inclusion Workshops.

There is a systematic approach to leadership & behavioural interventions through identifying performance gaps from trends in Condition Reports (CR), engagement survey results, nuclear safety culture survey results, Significant Operation Event Reports (SOER) & bespoke leadership surveys for leaders.

Examples of impact:

- Inclusion Workshops – Employee Engagement Survey results have improved since implementing this training especially in the area of teamwork (score increased by 6 points from 2012 to 2013)
- Accelerated Nuclear Leadership Programme – High Performance Index has improved from 50 in 2011 to 63 in 2013, recovering the previous existing gap with the fleet. Nuclear Safety Culture Survey Results 2014 have also improved since the leadership & behavioural interventions were introduced.

In addition to the initial NLP, Leadership principles have been summarized in a model developed by EDF-Energy based on international standards of excellence.
This model, called “behaviours for success” is a fleetwide programme which targets improved performance through behavioural changes. This model is promoted, deployed and used across the whole station.

## Behaviours for success

Nuclear generation works best where people consider themselves to be part of 'one team', are able to work to their full potential in an environment where organisational silos are removed and people are working together to achieve desired results. We see world class performance in many areas of our business and one of our primary objectives is to build on this and enable all leaders and teams to achieve the highest possible levels of performance.

The behaviours we see in our high performing teams have been captured in the form of a model we have called "behaviours for success". These behaviours combined with our management system will ensure the long term success of our organisation.

**1.1(1) Issue:** The station arrangements to maintain current high level of performance in terms of safety and reliability are not refined enough to ensure proactive continuous improvement in the near and long term.

The station has had continuously improving records in safety and reliability for 3 consecutive years, however, during the mission the team observed deficiencies with the implementation of proactive measures to increase safety and reliability in the near and long term. Shortfalls were identified in three areas:

Adverse record/trending and recurrent issues:

- Current CC1 (Critical Components) backlog is at industry norms but is static at approximately 100. However the Defect Backlog is higher than industry norms. Defect Backlog has increased since the beginning of the year 2015.
- Record of past generation losses: the overall performance of the station over the past 3 rolling years in terms of UCF (Unit Capability factor) is 88,19% which places the station in the middle of the second quartile of worldwide PWRs although the station has a favourable 4 trains design which could enable better performance.
  - The total number of unwanted (spurious) fire alarms is 51 since the beginning of the year. This is a potentially adverse trend since 44 were reported in 2013 and 54 were reported in 2014. Each time a spurious alarm is received, Operations are required to intervene and this is an unnecessary distraction. Furthermore, high number of spurious alarms may reduce staff attention to such alarms.
  - On the 24th of November 2014 there was a spill of sodium hypochlorite from the Hydrogen Disentrainment Tank bunded area onto the adjacent ground. The approximate strength of the Hypochlorite was 0,024%. Root causes are the following: inadequate use of operating experience feedback; this is a repeat event; design inadequate; preventive maintenance inadequate; the high level switch did not operate due to silt blockage (it was a known problem). Not solving root causes from the previous event leads to this repeated events.

Transition planning:

- The Off Site Radiological Survey Function was transferred from Sizewell A to Sizewell B in March 2015. Although INA (Independant Nuclear Assurance) recommended to bridge gaps with respect to requirements compliance some were still pending at the end of June 2015, eg: revision to Surveillance Programme 2 is still outstanding and competency development is needed (License condition 11).
- The first transfer of spent fuel to the Dry Fuel Storage, which is still under construction, is scheduled to take place before the next outage. The contingency delay plan for the project is 2,5 years and includes:
  - The Safety Case for the Dry Fuel Storage has been challenging. A number of aspects of the safety case caused delay; one of them being the design of the cask with two barriers required by EDF-Energy nuclear safety principles. ONR still has two licensing hold points to release before spent fuel can be transferred to the Dry Fuel Storage.
  - Since the initial contract was placed, the schedule slippage has been 6 months over a total duration 3.5 years.

- The PFHM (Pond fuel handling machine) was originally scheduled for an upgrade in 2008, but this was delayed. The completion of the modification is due in February 2016.
- Euratom design shortfalls are still pending with the Ion Fork installation.

If any more major delays occur (such as emergent issues during commissioning with adapted equipment for Sizewell B such as cooling system) or new challenges are brought by ONR or Euratom, the project could be delayed with possible impact on the station operability.

- There are no Radiation Protection monitors at the exit of the site. Proactively implementing this additional RP barrier could lead the plant to meet best international world practice.
- The station has a secure improvement/investment plan for the next 5 years. The corporate level has launched a 40/60/80 years life time duration equipment reliability, investment plan and business case analysis programme to secure a complete and deliverable extended life plan for Sizewell B. A progress meeting took place at the plant on the 13th of October with a presentation to the Engineering staff. The deliverables and presentation to the Boards are expected within 2 years (8 years before plant mid life time considering 60 years). Uprates and load follow modifications may be considered in the future. Should any major investment be decided at the corporate level with respect to a 30 years mid life, contract for long lead equipment will need to be placed with no further delay in order not to miss the mid life target.

Competencies and staffing (in the context of the large staff renewal that will occur in 5 to 10 years time):

- The station does not use a unique tool for competencies mapping. Inconsistent use of tools could lead to difficulties in identifying competencies weaknesses at the station level.
- The PSR2 review identified the following as one of the 44 priority observations. "The justification of the Staffing Levels for the roles which are identified within the Sizewell B Safety case is not well documented within the nuclear baseline."
- INA (Independent Nuclear Assurance) identified in a report issued in June 2015 that Operations does not have a robust long term resource station commensurate with the lead times for key positions.
- Several acting managers have been identified throughout the station organization chart:
  - 1 acting manager (Work Management) for 3 weeks;
  - 3 acting group heads acting:
    - Maintenance/Process Computing Group (PCG) group head: incumbent retiring in 2017;
    - Work Management/ Work planning control group head: due to succession chain for Work Management Manager;
    - Engineering/Programmes and components group head: group head covering two sections until arrival of external recruit in Jan 2016).

Temporary positions in line management imply less guidance to subordinates.

- INA (Independent Nuclear Assurance): 3 positions exist at the station for INA. One has been vacant since April 2015. Out of 24 INA positions for EDF-Energy fleet, 4 positions are vacant (one being at Sizewell).

Not implementing proactive measures to increase safety and reliability in the near and long term may put long term performance at risk.

**Suggestion:** The station should consider implementing proactive measures to enhance performance in the near and long term in order to continuously improve safety and reliability of the station performance.

**IAEA Basis:**

NS-G-2.4
5.11. The operating organization should demonstrate a commitment to achieving improvements in safety wherever it is reasonably practicable to do so as part of a continuing commitment to the achievement of excellence. The organization's improvement strategy for achieving higher safety performance and for more efficient ways to meet existing standards should be based on a well-defined programme with clear objectives and targets against which to monitor progress.

## 1.4. DOCUMENT AND RECORDS MANAGEMENT

**1.4(1) Issue:** The station policy and processes are do not ensure that station documents are always controlled in a consistent and compatible manner throughout the station.

During the mission the team observed deficiencies with respect to documentation revision control and use of uncontrolled documents. Shortfalls have been identified in several areas: corporate procedures applying to the plant, Operations' documentation, Emergency preparedness documentation, and RP documentation.

Corporate documentation applicable to the station:

71 corporate documents that apply to the station have not been reviewed within the 3 year period required by corporate policies.

Operations' documentation:

- POIs (Plant Operating Instructions), SOIs (Station Operating Instructions) and STOs (Surveillance Test Operations) are not all reviewed periodically and uncontrolled documents are available to Operations staff.
- The PSR2 review identified the following as one of the 44 priority observations: "Infrequently used Nuclear Safety related procedures are not periodically reviewed, except during their occasional use". The following deviations were observed in the Auxiliary Shutdown Room (ASR):
  - Sizewell B Emergency plan drawing of the main buildings on the site is as of 1999. Buildings such as Spent Fuel Dry storage and Security staff buildings are not included.
  - About 9 folders with "Uncontrolled" station system drawings are available in the ASR. In one of the folders "controlled" and "uncontrolled" copies were found.

Emergency preparedness documentation:

Documents that are used for emergency response, but not controlled by Emergency Preparedness staff, are not consistently maintained and updated in a timely manner. Personnel from Operations, Maintenance, Technical Support, Radiation Protection and Chemistry add uncontrolled documents to reference binders to complement existing controlled documents at the Emergency Control Centre, the Technical Support Centre, the Strategic Coordination Centre, Muster Points and the Access Control Point. A total of 12 deficiencies were identified including existence of: old documents, incorrect revisions and uncontrolled documents, document with absence of date.

RP documentation:

2 types of radiation protection related procedures exist at the station (RWP – Radiological Work Permit- & Health Physics Instructions). These procedures are managed electronically and controlled copies exist in the offices, however the team noted the following:

- A hard copy of a small number of RWPs past their expiry date: in this case the version printed from AMS (Asset Management System) onto the WOC (Work Oder Cards) showed that the version had expired and should not be used.

- HPCIs (Health Physics and Chemistry Instructions) still labelled with ‘British Energy’ masthead (HPCI SN153, SN162, SN164, SN176)
- White paper copies present instead of the expected ‘gold’ copy. (HPCI-SN330 & SN400).

Events involving documentation issues:

Significant Events:

- On the 20th of November 2014, reactor cooling was changed from RHR train A to RHR train B. The requirement to analyse the stand by RHR train boron concentration within 3 hours prior to placing in service was not completed. The potential consequence is inadvertent dilution of the RCS affecting reactivity and shut down margin. Root cause: over reliance on Operator training and memory to identify the need for sampling and failure to incorporate adequate barriers within procedures to mitigate the risk.
- On the 18th July 2012 an automatic reactor trip occurred following MG set 2 return to service. Besides actions to improve equipment reliability, one of the actions taken by the plant to tackle the issue was to revise the POI SU02 to include specific checks of the state of the circuit breaker status relays 1X08/2X08 prior to synchronising either MG Set to the other.
- Additional events related with procedure root cause include Priority level 1 and 2 (4 events recorded between May 2013 and December 2014) and Priority level 3 and 4 (8 events recorded since October 2013).

Existence of uncontrolled document copies and inconsistent document revision policy may impact nuclear safety.

**Suggestion:** The station should consider improving its documentation policy and control to ensure that station documents are always controlled in a consistent and compatible manner throughout the station.

**IAEA Bases:**

NS-G-2.4
6.75. Documentation should be controlled in a consistent, compatible manner throughout the plant and the operating organization. This includes the preparation, change, review, approval, release and distribution of documentation. Lists and procedures for these functions should be prepared and controlled.

6.76. A records administration and documentation system should be established to ensure the appropriate keeping of all documents relevant to the safe and reliable operation of the plant, including design documents, commissioning documents, and documents relating to the operational history of the plant as well as general and specific procedures. Particular care should be taken in order that, although all versions of each document are appropriately filed and kept as a reference, only the correct, up to date versions are available to the site personnel for day to day activity.

## 1.9. SAFETY CULTURE

**1.9(a) Good practice:** Daily Safety Message and Station Status Brief

All work groups, including contractors, start the day with a common brief, to ensure fitness for duty and an understanding of station status and priorities. A common daily safety message is also discussed.

This is a two or three stage process. The station management team hold their brief, using information from the Operations Shift Manager's log. The brief includes station status and also the operational priorities set by the Shift Manger. Daily condition reports and other new OPEX are considered. There is discussion of the daily safety message, which is used at all locations (power stations and headquarters) in the Nuclear Generation organization. The managers then cascade this brief to all their workers in one or two further stages. These briefings also include a check that everyone is fit for work.

Once this has been completed each supervisor continues with setting his team member(s) to work (Setting to Work) by ensuring they are SQEP (Suitably Qualified and Experienced), that they have the correct documentation, and that they have received an appropriate Pre-Job Brief.

The Pre-Job Brief is specific to the task, where the supervisor and team members discuss error likely situations, safety concerns, critical steps, previous operating experience, and the use of error prevention tools to control any identified issues.

Because of the daily safety message, staff has a good awareness of a wide range of safety requirements. The start of day brief also allows workers to mention any concerns they have regarding their fitness for their work. The use of the station log and condition reports allows all workers to know the state of the station, the key priorities all work groups must respect and any immediate OPEX.

# 2. TRAINING AND QUALIFICATION

## 2.2. QUALIFICATION AND TRAINING OF PERSONNEL

The station has included Nuclear Safety Engineers as Subject Matter Experts in Training sessions for Operations Main Control Room (MCR) staff, when applicable. The benefit of including Nuclear Safety Engineers as subject matter experts is to improve the MCR staff understanding of fault progression, and to act as the station safety case expert. The team has identified this as good performance.

A Desktop Simulator written in Visual Basic for Microsoft Excel is available for all Station personnel. The key use for the package is in familiarizing new starters/graduates with the main station systems and behaviour of the station in both automatic and manual modes. The team has identified this desktop simulator and its application as a good practice.

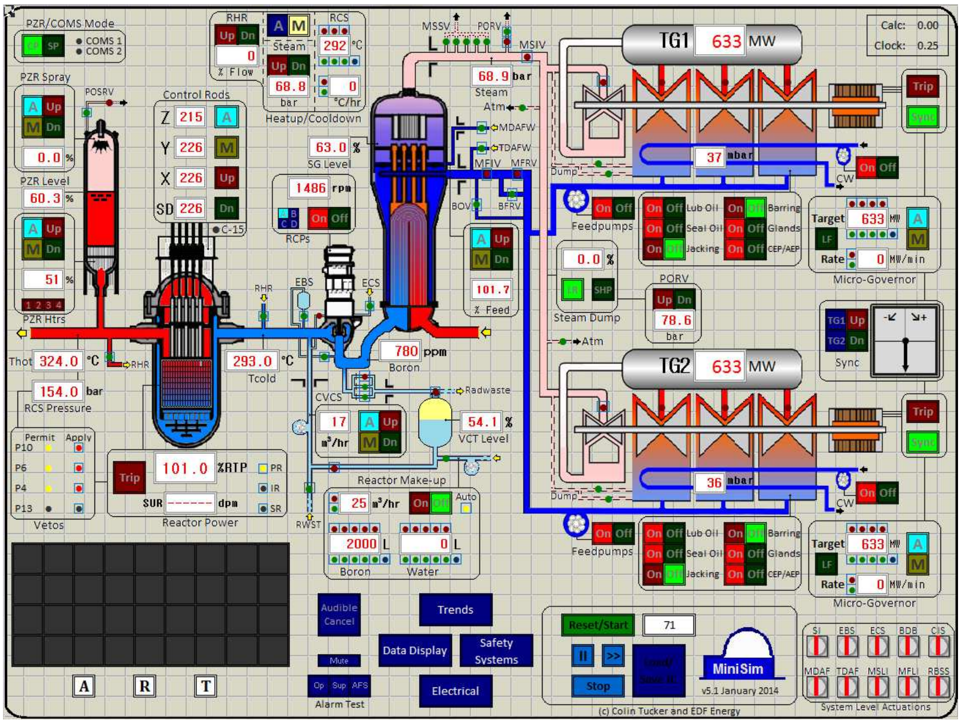
The training facilities at the station reflect a strong commitment to high quality training. The station uses an off-site "Excellence Centre" Training facility that allows staff to be trained and then assessed in a safe, yet realistic station-like training environment. The learning environment of this facility has enabled learners to walk away from their training session with new and/or reinforced skills, knowledge and behaviours which they can transfer to their station work environment. The team recognizes the learning methods utilized at this facility as a good performance.

## DETAILED TRAINING AND QUALIFICATION FINDINGS

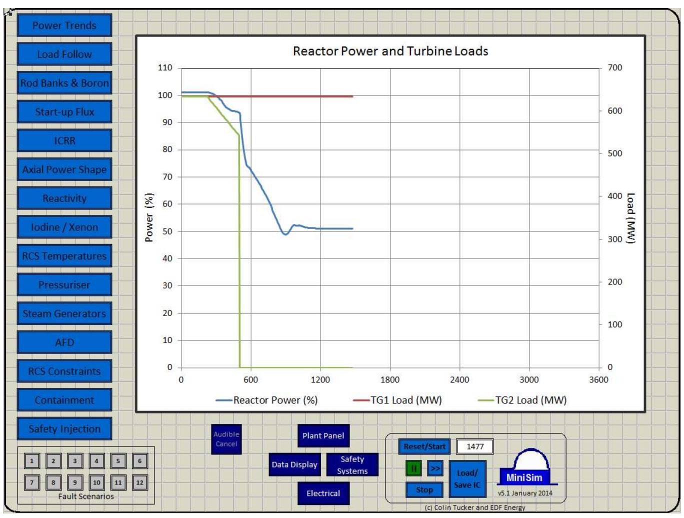
### 2.2. QUALIFICATION AND TRAINING OF PERSONNEL

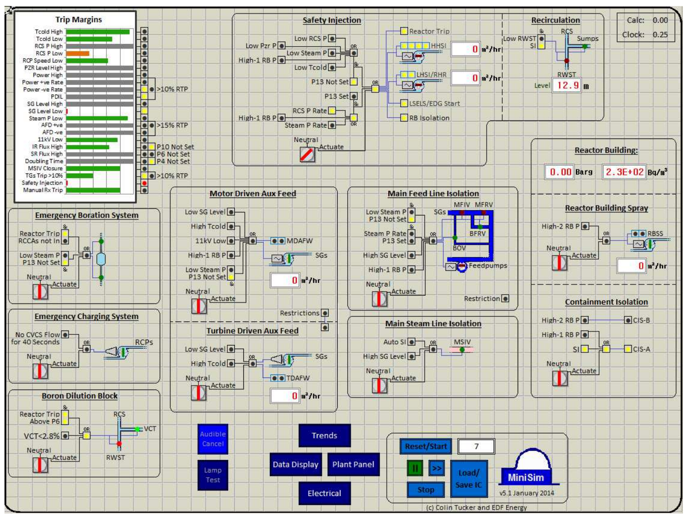
**2.2(a) Good Practice**: Desktop Simulator written in Visual Basic for Microsoft Excel is available for all Station personnel.

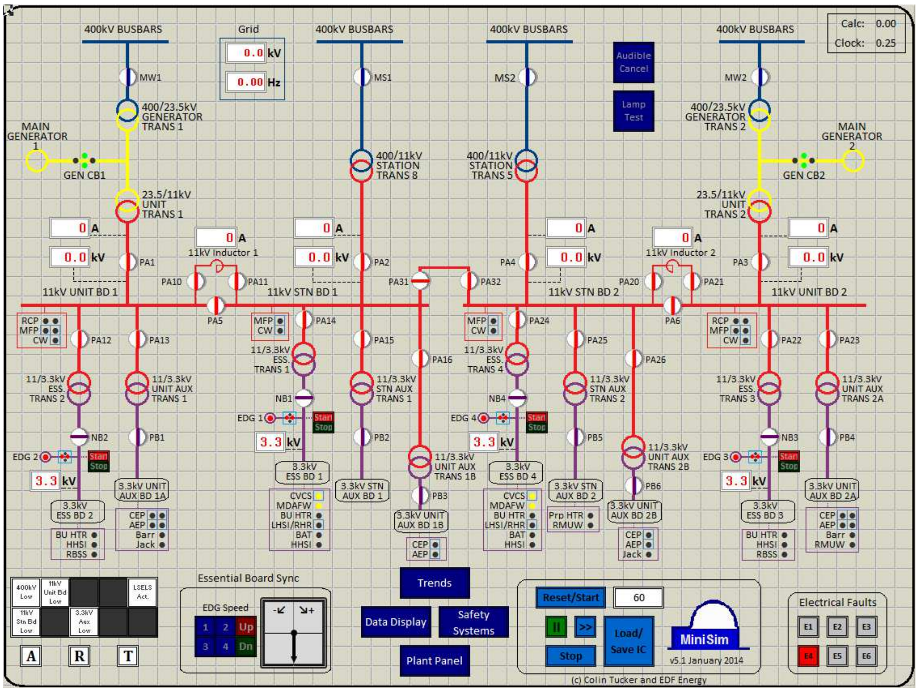
MiniSim provides a *Sizewell-specific desktop simulator* for use in introducing the principles of PWR operations. Unlike other such packages, it is written in *Visual Basic for Microsoft Excel* and so can be easily copied and run on any computer at work or at home.




It has developed in response to requests from trainers and it can be easily adapted as future requests or training needs arise. Detailed instructions are included, together with Station Operating Instructions for station start-up and power-raising, station cool-down/heat-up, post-trip actions load-follow operations.






The key use for the package is in introducing new starters/graduates to the main station systems and to the behaviour of the station in both automatic and manual modes. The package includes modelling of Safety and Electrical Systems and covers a range of fault scenarios (e.g. station blackout, small LOCAs etc.) in addition to normal station operations.

Its use is formally included within the Mentor Guides for Nuclear Safety Group Graduate Attachments.

A second 'Generic' version of MiniSim (a single Turbine model, which can be run in French or English) has been cleared for wider distribution and is in use at a number of UK universities.

# 3. OPERATIONS

## 3.3. OPERATING RULES AND PROCEDURES

Team observed that periodic review of control room and field operator procedures for the Station Operating Instructions (SOI) and Plant Operating Instructions (POI) categories is not required by the station policy. The team has found some procedures that have not been reviewed for several years. In addition, some operator aids, throughout the station, are not controlled. The use of uncontrolled operator procedures and aids may compromise station safety. The team made a recommendation in this area.

## 3.4. CONDUCT OF OPERATIONS

Routine field operator rounds do not always provide for consistent, timely identification and reporting of deficiencies to ensure they can be effectively addressed in a timely manner. The station has an action plan to improve operator rounds, however the effectiveness of this plan is not yet demonstrated and therefore the team suggests reinforcing station expectations in respect of field operator rounds.

## 3.5. WORK CONTROL

The station developed a system of colour coded symbols for identifying electrical panels on switchboards for each circuit. The use of this system provides a good and simple human error preventive tool and the team considers it as a good practice.

The team also identified good performance in the usage of different coloured defect tags for each fuel cycle so the defects from previous fuel cycles can be easily identified.

## 3.6. FIRE PREVENTION AND PROTECTION PROGRAMME

The station has in place a system for ensuring fire safety. However, the team observed weakness in fire protection equipment reliability, control of combustible materials and fire team drills. The team suggested that the station consider improving its arrangements for ensuring fire safety.

## 3.7. CONTROL OF PLANT CONFIGURATION

The team observed some deviations from configuration control policy. The team encourages the station to assess these deviations to fully understand the potential consequences to safety and to improve station configuration control practices.

## DETAILED OPERATIONS FINDINGS

### 3.3. OPERATING RULES AND PROCEDURES

**3.3(1) Issue**: The station policy and practices with regard to handling and use of operating procedures and operator aids are not robust enough to ensure that current and correct documents are used by the operators.

The following observations were made.

Procedures:

- A review of the list of procedures updated within the last 30 days showed that many hardcopy procedures in the Main Control Room had not been updated in a timely fashion.
- The Auxiliary Shutdown Room Procedure SOI-7-4-1 references Procedure SOI–8-8. However, there was no paper copy of Procedure SOI–8-8 available in the Auxiliary Shutdown Room.
- Operating instructions on Panel 1AE-PNL-0061 are not controlled as required by the station's policies.
- Procedure SOI 7.1 was added to the procedures SOI 8.1 and SOI 8.2 folder in 2008, however this inclusion was marked just by a yellow sticker on the folder. There is no clear indication as to why SOI 7.1 was placed in the SOI 8.1 and SOI 8.2 folder.
- Procedures listed below had not been updated to the current version in the Operator Plant Office:
  - Turbine Trip actions – SOI 5.4.1 rev. 028. The newest version is rev. 030.
  - Loss of Ultimate Heat Sink – SOI 5.4.3 rev. 015. The newest version is rev. 017.
  - Loss of grid 11KV – SOI 6.6 rev. 017. The newest version is rev. 019.
- Folder with "Conduct of Operations" procedures is not under the document control system and does not get updated. All procedures in the folder are from the time of British Energy. These are uncontrolled copies.
- A section of STO RL 008 Procedure rev. 8 used for training was found on a cork board in the Full Scope Simulator room. The newest version is rev. 18.
- Procedures at the Full Scope Simulator (and in the Main Control Room as well) are in disorder, have different folders and font sizes. The whole arrangement is not optimized for human performance.

Operator aids:

- In Main Feed Water Room East (R1412) there is an unauthorized operator aid (uncontrolled handwritten information) on valve 1AB-HV0290.
- In the field operators' office in the Turbine Hall, there is a Contingency Plan sheet for handling a red phase leak on the General Transformer. This sheet has unauthorized hand-written advice. The MCR staff has not been aware on how to deal with that written advice. A drawing dating back to 1988 was found on the wall of the field operator's office in the Turbine Hall. There was no evidence that

it was approved, controlled, current, and valid for operations. This drawing is available in the computer system. Two operators stated that if this version of the drawing is available in the computer system, it means it is valid.

- In staircase 4104 of the Auxiliary Building, the three floor plan drawings show no evidence of revision and are not controlled copies.
- In the Pump House, at ground level, eight uncontrolled floor plan drawings dating back to "British Energy" are hung below waist level and are not easy to read.
- At the entrance of the Radiation Controlled Area, in corridor 1560, three large floor plan drawings have no stamps or other evidence of being controlled.
- Drawing SZB-AP-S38101/11 in the Main Control Room was not controlled or updated.
- Operator aid number 98/63/AD was dated from 10/11/98.
- On the wall of the field operator office, a RCS/SIS drawing dated from 25/11/1993 was found. There is a stamp on it saying that it is an uncontrolled copy and "VALID ONLY AT TIME OF ISSUE".
- Operator aid (a label of recommended set points) not controlled was found on panel 1AC-PNL 3382.

Other (procedures and aids application):

- Shift technician used a Return to Service Sheet printed from the computer system as a reference. It contains verification steps (Y/N), dates, signature spaces which were not filled in.
- Five Return to Service Forms were randomly checked by the team. There are no common requirements on how to fill them in and apply them. Inconsistencies were observed in how the forms were filled.
- The Main Feed Water Pump 2B panel 1AE-PNL 0030 has a paper copy of uncontrolled documents attached to it.
- The station has experienced significant events caused by inadequate operating procedures in the past.

The use of uncontrolled operator procedures and operator aids compromises station safety as these items are not subject to document control and can thus result in human errors.

**Recommendation:** The station should enhance its policy and practices with regard to handling and use of operating procedures and operator aids to ensure that current and correct documents are used by operators.

**IAEA Bases**:

SSR-2/2

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

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

NS-G-2.14
4.22. “Procedures, drawings and any other documentation used by the operations staff in the main control room or anywhere else in the plant should be approved and authorized in accordance with the specified procedures. Such documentation should be controlled, regularly reviewed and updated promptly if updating is necessary, and it should be kept in good condition. Emergency operating procedures should be clearly distinguished from other operating procedures.”

6.15: “Operator aids may be used to supplement, but should not be used in lieu of, approved procedures or procedural changes. Operator aids should also not be used in lieu of danger tags or caution tags. A clear operating policy to minimize the use of, and reliance on, operator aids should be developed and, where appropriate, operator aids should be made permanent features at the plant or should be incorporated into procedures.”

6.16: “An administrative control system should be established at the plant to provide instructions on how to administer and control an effective programme for operator aids. The administrative control system for operator aids should cover, as a minimum, the following:

- The types of operator aid that may be in use at the plant;
- The competent authority for reviewing and approving operator aids prior to their use;
- Verification that operator aids include the latest valid information.”

## 3.4. CONDUCT OF OPERATIONS

**3.4(1) Issue**: The station operational practices do not always provide a consistent approach to identifying and reporting deficiencies in the field in a timely manner.

The following observations were made.

Control Room operations:

- The deficiency tag on a disconnector (WOC 08471145) on the MCR electrical panel was hung in 2007 with a projected resolution in 2017.
- The Control Room Alarms (CRA)/Control Room Defects (CRD) tracking sheet lists 11 MCR defects. However, there are 19 defect tags on the panel: 4 are marked as CRD, 3 as CRA and 11 not marked as either.

Shift routines and operating practices:

- There is a 15cm by 15 cm oil spot on the Emergency Charging pump 1FC-K03B. Contractor cleaners noted the leak 3 weeks ago but field operators have not identified or hung a deficiency tag.
- On the Motor Driven Auxiliary pump, a local indicator of motor end bearing oil temperature indicates “0”. However, the digital panel displays 27o C. This deficiency has not been tagged.
- There is a 30 cm2 oil spot under HHSI pump 1EM-D-P01C. No deficiency tag issued. A field operator toured the area the night before.
- Six oil pressure meters (gauges) on the Safety Injection Pump have unauthorized hand- written values. The escorting manager stated that this marked information is not correct. However the marking has not been removed.
- On TG-1 1AF-T01-1 is a small oil leak not identified or reported.
- The gauge “Condenser extraction pump 2B water seal” is defective, but has no tag. After the team alerted station management, operators were told to identify the deficiency and hang a tag.
- There is a 4cm x 4cm oil leak beneath the bearing of component Cooling Water Pump “A”. The leak was not tagged and reported.
- A deficiency tag dated April 2009, indicated a transmitter deficiency with replacement required. Work order 10003524158. A field operator was coaching a new operator while performing a detailed tour. He did not notice several deficiencies: scaffolds in the Room 3720 not installed on metal toes, more than 10 lighting bulbs blown, storage of combustible packages and wooden bricks in Room 3723, and pipe metal separators after repair of the equipment.
- Numerous penetrations (over 10) still have temporary labels dating back to the construction phase (one is dated 1991). These are not addressed by operators as deficiencies.
- One “green” bulb is blown on the Pump House electrical panel 1EA-PNL0009
- Pump House (ground level) local control panels 1DC-PNL0011 and 1DC-PNL0003 have actuated alarm lights. That signal to 1DC-PNL0003 is initiated by trace heating 1Q-PNL0043 and then goes to the Control Room. The deficiency is in the database, but neither a Work Request nor a deficiency tag has been issued.

- Failure to identify and report deficiencies in a timely manner may result in equipment inoperability.

**Suggestion:** The station should consider enhancing operating practices to ensure that deficiencies in the field are identified and reported in a timely manner.

**IAEA Bases**:

NS-G-2.14

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

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

4.36. "Factors that should typically be noted by shift personnel include:

- Deterioration in material conditions of any kind, corrosion, leakage from components, accumulation of boric acid, excessive vibration, unfamiliar noise, inadequate labelling, foreign bodies and deficiencies necessitating maintenance or other action;
- The operability and calibration status of measurement and recording devices and alarms on local panels throughout the plant, and their readiness for actuating or recording;
- The proper authorization for, and the condition and labelling of, temporary modifications in the field (e.g. the presence of blind flanges9, temporary hoses, jumpers and lifted leads in the back panels);
- Indications of deviations from good housekeeping, for example the condition of components, sumps, thermal insulation and painting, obstructions, posting of signs and directions in rooms, posting of routes and lighting, and posting and status of doors;
- Deviations from the rules for working in safety related areas such as those relating to welding, the wearing of individual means of protection, radiation work permits or other matters of radiation safety or industrial safety;
- Deviations in fire protection, such as deterioration in fire protection systems and the status of fire doors, accumulations of materials posing fire hazards such as wood, paper or refuse and oil leakages, or industrial safety problems such as leakages of fire resistant hydraulic fluid10, hazardous equipment and trip hazards;
- Deviations in other installed safety protection devices, such as flooding protection, seismic constraints and unsecured components that might be inadvertently moved."

4.37. “Operators should assume that instrument readings are accurate unless proven otherwise. Ignoring an unusual reading can lead to abnormal conditions going undetected.”

4.42. “The shift supervisor and control room operators, when properly relieved or not on shift, should spend some time walking through the plant and observing field operators carrying out their activities. These observations should be appropriately documented and, when necessary, corrective actions should be developed, prioritized and tracked. Best practices include documenting minimum requirements as a basis for written field observations.”

7.34. “The shift supervisor and the operations manager should conduct periodic walkdowns in the plant to observe the tagging process and the process for bringing equipment back into service, and in particular the process for filling and venting a drained system or component in a manner that ensures the industrial safety of field operators. If supervisors detect any non-compliance with the relevant industrial safety standards, it should be corrected immediately and communicated in accordance with established procedure for the feedback of operational experience.”

NS-G-2.4
6.33. “The shift crew should perform regular rounds through the plant. The shift supervisor or authorized staff should also walk through the plant periodically

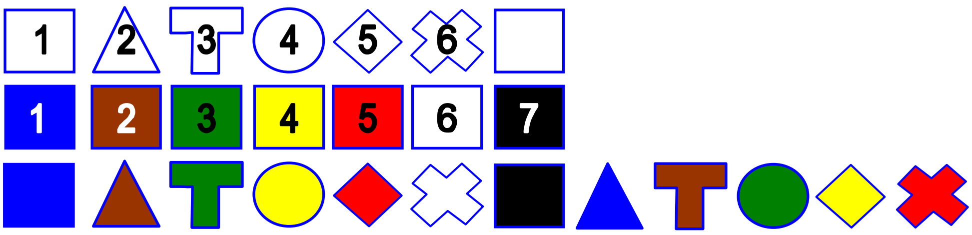
3.5. WORK CONTROL

**3.5(a) Good Practice:** Colour coded symbols for identifying electrical panels on switchboards.

A system for identifying electrical panels on switch boards uses a shape/colour recognition symbol for each circuit. All the related doors and covers for each circuit are given a symbol that is different from neighbouring circuits. There are six shapes that are repeated in order. There are also seven colours that are repeated in order so that the first circuit is a blue square, on the seventh circuit the square is repeated but the colour is black. The next time the square is repeated it is a white square. Using this system the blue square is repeated every forty two circuits. Most switch boards have less than forty-two circuits. On the few occasions where are more than forty-two circuits, they will be so far apart that it should be obvious that they are different circuits. The colour shape recognition symbols use six shapes and seven colours to produce 42 different symbols.

These coloured shapes are used in secured communication, especially when people are working at the front and the back of the cubicle at the same time, insuring they are working on the same components, avoiding a mismatch.

*Picture of colour coded symbols*




## 3.6. FIRE PREVENTION AND PROTECTION PROGRAMME

**3.6(1) Issue:** The station arrangements for fire protection are not robust enough to always ensure the reliability of fire protection equipment, control of combustible materials and adequate fire team drills.

The following observations were made.

Fire protection equipment:

- Valve lock devices are not properly applied. Deluge valves can be closed without opening the lockers or breaking seals. The following areas were verified with deficiencies:
  - Essential Diesel Generator 2
  - Main transformer 1;
  - Essential Transformer 4;
  - Turbine building -0.20m;
  - Aux. Transformer 1A;
  - Aux. Transformer 1B;
- TG-1 extinguisher DP 258 had been tested (confirmed by the station documentation) but the signature on the extinguisher itself had been omitted.
- Fire door 1005 electric drive mechanism was found deficient and without a defect tag.
- Fire door D1341/42 has required a new ram seal since 12/11/2014, and had a defect tag dating back to 07/08/2015. Fire door 6103 (Fuel pond heat exchange room) was found open.
- Damaged fire system air release nozzles on TG-2, TG-1 and main feedwater pump 2B.
- Fire door 4557/4146 lock was broken. There was no defect tag. The door is located in front of Operations Plant Office (room 4573).
- Fire door 1019 (Safety Injection Pump C) DT 11105100417 dated from 28/11/2014. Oil leak on hydraulic cylinder that closes the door.
- Fire door 1020 (Containment Spray Pump B) DT 11105002029 dated from 04/06/2014. Local alarm not working.
- Fire pump 1 deficiency on oil system identified on 7th of October was repaired. Return to service test identified excessive gland seal leakage on 11th of October (WO01735737) compromising reliability.

Combustible material storage:

- An “Authorization for use of site/plant areas for storage/accommodation” number 241 dated from 02/07/2009 was found in turbine building at access door to turbine oil tank. The form is not updated according to the current procedure.
- Turbine building - Room 4194 elev. -0,20m: 4 containers (6x3x2,5m each) are stored below electrical cable rails containing class A fire materials (cleaning materials, hoses, solvent, paper box, plastic reservoirs, wood).

Firefighting drills:

- Fire exercise drill has not been performed since 2012 with the external fire brigade, and records are not available for this exercise.
- In the last ten years fire exercises involving External Brigade were performed in 2006, 2007, 2011 and 2012. However, records are not available to support effective evaluation of the results and overall adequacy of the firefighting exercises.

The station has experienced several events in the past:

- An event involving fire protection equipment that resulted in a loss of automatic fire suppression in two areas.
- An event that resulted in fire in a temporary sampling installation at the cooling water forebay.

Without appropriate arrangements related to fire prevention and protection the station safety may be compromised.

**Suggestion:** The station should consider enhancing its arrangements in respect of fire protection equipment, control of combustible materials and adequate fire team drills.

**IAEA Bases:**

SSR-2/2
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…”

5.24. “The operating organization shall be responsible for ensuring that appropriate procedures are in place for effectively coordinating and cooperating with all firefighting services involved. Periodic joint fire drills and exercises shall be conducted to assess the effectiveness of the fire response capability.”

NS-G-2.1
2.20. “Regular fire exercises should be held to ensure that staff have a proper understanding of their responsibilities in the event of a fire. Records should be maintained of all exercises and of the lessons to be learned from them. Full consultation and liaison should be maintained with any off-site organizations that have responsibilities in relation to fire fighting.”

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

6.3. “The total fire load due to combustible materials in each area identified as important to safety should be maintained as low as reasonably practicable…”

6.6. “Administrative procedures should be established and implemented to provide effective control of temporary fire loads in areas identified as important to safety during maintenance and modification activities…”

7.1. “A comprehensive programme should be established and implemented to perform appropriate inspection, maintenance and testing of all fire protection measures (passive and active, including manual firefighting equipment) specified as important to safety…”

7.2. “The inspection, maintenance and testing programme should cover the following fire protection measures: passive fire rated compartment barriers and structural components of buildings, including the seals of barrier penetrations; fire barrier closures such as fire doors and fire dampers…”

10.1. “Fire protection features are not generally classified as safety systems and thus they may not be subject to the rigorous qualification requirements and the associated quality assurance programme applied to safety systems. However, fire has the potential to give rise to common cause failure and thus to pose a threat to safety, and therefore the installed active and passive fire protection measures should be considered safety related. An appropriate level of quality assurance should therefore be applied to fire protection features.”

NS-G-2.6
8.33. “Plant management should make administrative arrangements to ensure that the storage facility is operated in a manner that preserves the proper environmental conditions, guards against fire hazards and prevents unauthorized access to stored items…”

8.34. “The administrative arrangements should include written procedures assigning the responsibility for regularly examining stored items and auditing the administration of stores in order to detect any deterioration or any unauthorized or unrecorded use of stored items. Particular attention should be paid to retention of the original identification of items during storage.”

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

# 4. MAINTENANCE

## 4.2. MAINTENANCE FACILITIES AND EQUIPMENT

The station adopted a scheme of mechanical key interlocks to prevent unauthorized access to Reactor Protection System (RPS). All cubicles and transmitter racks related to the RPS are accessed via hinged doors fitted with a mechanical lock and key system, which allow authorized access at power, to only one train per system at a time for normal maintenance and testing. There have been no cases of unauthorized access to the RPS as a result of this mechanism. The team recognized this as a good practice.

The station has adopted an effective way of locating condenser tube leaks. By coating the entire tube plate of the leaking condenser in shaving foam, the leaking tube can be quickly identified, as the leaking tube is revealed by a depression in the foam coating over the end of the leaking tube. The method has proven to be effective, reliable, environmental friendly, and has reduced the downtime of condenser. The team identifies this as good performance.

## 4.5. CONDUCT OF MAINTENANCE WORK

The team observed that station maintenance activities were not always prepared, controlled and implemented in a manner to ensure equipment and personnel safety. Worksites are not always properly prepared and controlled, human error prevention tools are not always used or used effectively, and torque settings are not always specified in working instructions. The team made a suggestion in this area.

## 4.6. MATERIAL CONDITION

The team identified that the Foreign Material Exclusion (FME) Programme is not strictly implemented at the station. Barriers around the spent fuel pool were inadequate, logs were not filled out per the station expectation, and some FME areas are not fenced off. There were several FME events and near-miss events in 2015. The team made a recommendation in this area.

Although the total number of leaks has been reduced in the recent past, the team observed that the station still has a relatively large number of leaks. The team encourages the station to continue its effort in reducing the number of leaks.

## 4.7. WORK CONTROL

The station has used the risk-monitor process extensively to plan its on-power and outage maintenance activities. A case in point is that the risk profile for outage R13 has demonstrated risk-informed activity planning. The team recognized this as good performance.

The team observed that there are 18 compliance related preventative maintenance (PM) activities overdue at this moment in the station, and 12 out of 18 are on the systems related to the Heating, Ventilation, and Air-Conditioning System (HVAC). The team encourages the station to make further efforts to reduce overdue PMs.

# DETAILED MAINTENANCE FINDINGS

## 4.2. MAINTENANCE FACILITIES AND EQUIPMENT

**4.2(a) Good practice:** Use of a mechanical key interlock scheme to prevent unauthorized access to the Reactor Protection System and other safety related equipment.

The station Reactor Protection System (RPS) comprises of 2-off diverse 4-train independent protection systems. The Primary Protection System (PPS) and the Secondary Protection System [SPS] provide both diverse Reactor Trip (Scram) and post-trip Engineered Safeguards Features (ESF).

Both systems are designed to allow authorized access at power to only one train per system at a time for normal maintenance and testing. All cubicles and transmitter racks are accessed via hinged doors fitted with a mechanical lock and key system.

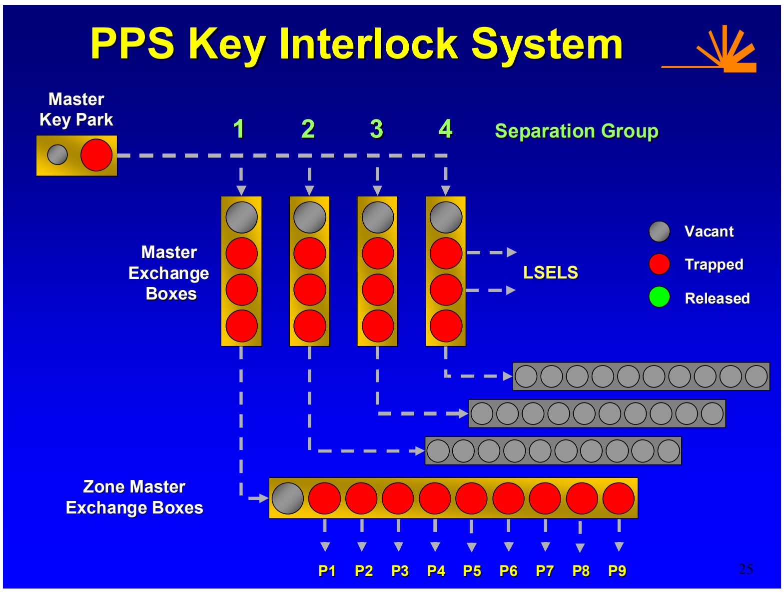
The master key (one per system) gives access to a Separation Group (Train) Master key box that releases keys in cascading order to further key exchange boxes, located in the Plant adjacent to the related cubicles and transmitter racks. Keys from the slave boxes are then released to open the doors to the cubicles for testing and maintenance.

Each key is unique, and the release of a key from the master box prevents the release of a key from another Separation Group until the first released key is returned. The slave boxes also retain their sub-master key which can only be released when all of the individual door keys are returned.

Thus the key system allows maximum access for testing and maintenance while preventing inadvertent trip or actuation due to testing or maintenance activities.

This supplements Human Performance and administrative controls to give an additional layer of defense during Nuclear Safety related equipment work.

There have been no cases of unauthorized access to the Reactor Protection System as a result of this interlock scheme.



## 4.5. CONDUCT OF MAINTENANCE WORK

**4.5(1) Issue:** The station maintenance activities are not always prepared, controlled and implemented in a manner that ensures equipment and personnel safety.

The team noted the following:

- Work on valve (1EM-V3109) for the lube oil filter for high head injection pump C:
  - A torque wrench was not used to torque the valve packing to the recommended value as specified on the drawing during the maintenance work on valve (1EM-V3109) for the lube oil filter for high head injection pump C. The maintenance procedure did not require the use of a torque wrench during this step.
  - A torque wrench was not used to torque the valve body into place. The maintenance procedure did not require the use of a torque wrench during this step.
  - Maintenance tools were not placed in the laydown area in an orderly manner during the maintenance on the valve (1EM-V3109). Some tools were placed on nearby equipment, and others were placed on the pump C bed plate.
- Work on Essential Service Water (ESW) pump C outlet venting Valve (1EF-V0054):
  - Floor grates at the worksite were not protected to prevent small items from falling through to the floor below.
  - Wrenches, spanner, bolts and nuts in plastic bags and lubricants for bolts were placed on the Pump inlet pipe with the potential to slip off.
  - The plastic bag containing bolts and nuts was broken during the work, and the bolts and nuts fell through the floor grates down to the floor below.
  - A soft Foreign Material Exclusion (FME) cover was used as bag for used bolts and nuts.
  - The worksite was not fenced off.
  - The above situations were not challenged by the three workers within the group.
- The worksite for ESW Pump C maintenance area was not completely fenced off while work was in progress.
- The work sites were not fenced off during maintenance work on the ESW Strainer (1EF-F01C).
- Several white paint traces were identified on the driven-end bearing seal surface of the motor driven auxiliary feed water pump B after its disassembly. The paint traces were left from a previous disassembly of the pump, and were not cleaned prior to assembly.
- The pre-job brief for the test of the Load Shedding Sequencer logic check for 3.3kV essential electrical board 3 was not conducted in a structured manner as outlined in the Green Card Brief. Although most of the elements were covered, key points were not emphasized in a concise manner.

- Three way communication was not used as intended during the test of Load Shedding Sequencer logic check for the 3.3kV essential electrical board 3. The worker and the team lead did not challenge each other for not using three way communication.
- On 16 September 2015 during leak testing on the condensate system, the test equipment used for this activity was connected to the incorrect Condenser Extraction Pump (CEP). Not using human error prevention tools (such as pre-job briefing, point touch verbalize, peer check, and three way communication) has been identified as the main cause.
- On 4 August 2014, when working on the controller (1AB-PC0277) for the loop 2 steam generator Power Operated Relief Valve (PORV) (1AB-PV0277), an unauthorized parameter setting was used. This caused the manual close button to open the PORV and the open button to close the PORV. This condition was not identified from 4 August to 26 September 2014 as the automatic control worked correctly.

Inadequate preparation and control of maintenance activities may increase the risk of equipment damage and personnel injuries.

**Suggestion:** The station should consider improving its preparation and control of maintenance activities to ensure equipment and personnel safety.

**IAEA Bases:**

SSR-2/2
4.29. Aspects of the working environment that influence human performance factors (such as work load or fatigue) and the effectiveness and fitness of personnel for duty shall be identified and controlled. Tools for enhancing human performance shall be used as appropriate to support the responses of operating personnel.

8.3. The operating organization shall develop procedures for all maintenance, testing, surveillance and inspection tasks. These procedures shall be prepared, reviewed, modified when required, validated, approved and distributed in accordance with procedures established under the management system.

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

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

GS-G-3.1
2.21. All work that is to be done should be planned and authorized before it is commenced. Work should be accomplished under suitably controlled conditions by technically competent individuals using technical standards, instructions, procedures or other appropriate documents.

NS-G-2.14

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

4.45. In communications, the full description of any plant item should be given and the phonetic alphabet should be used where appropriate. To reduce the likelihood of error in verbal communication, both in the plant and in control rooms, training should be provided in the use of three way communications between the sender and recipient and this method should be used as widely as practicable, especially in abnormal situations.

NS-G-2.6

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

5.7. In the process of preparing procedures, in particular in determining their technical content, reference documents should be used. These reference documents should include appropriate drawings, codes, standards, instruction books and manuals, as provided by the design organization, construction organization, equipment suppliers and operating organization.

## 4.6. MATERIAL CONDITION

**4.6(1) Issue:** The Foreign Material Exclusion (FME) programme is not strictly implemented to prevent foreign material from entering station systems and components.

The team noted the following:

In the Fuel Building:

- A two (2) meters wide opening in the FME barrier around the spent fuel pond was not restored. There was no work in progress and no staff present at the time the opening was identified.
- The records in the FME Area Control Log Form for the spent fuel pool were found not legible, stroked out, corrected, not completed, or not verified.
- A thin layer of dust, insects and other light objects (potentially from intake air) were on the surface of the flask fill bay water, with the potential to connect to the spent fuel pond.
- An unattended power cord was left in the spent fuel pond FME area.

In other areas:

- The worksite barrier was not in place during the lube oil cooler 2A maintenance work (a FME standard work). No work was present at the worksite at that time.
- A large piece (60cm x 60 cm) of clear plastic was found in the radioactive waste building.
- A large number of defective FME covers (soft or plastic, more than 30) were found in the maintenance workshop, the pump house and the Radiological Controlled Area (RCA) tool shop reception areas:
  - having foreign material inside, such as sand and debris,
  - degraded with inside lining detaching,
  - broken
- A FME cover was missing on a flange to a steam generator drainage pump. (BMV 0309, Room 1161)
- No FME cover was on the open fire hydrant open pipe for Hydrant 1 KC V0369.

Station events:

- On 11 October 2015, during a forced helium dehydration function testing, a pressure relief disc burst on the dummy heat load cask with the system pressurized with helium. The heat lagging insulation covering the pressure relief disc was dispersed and a small amount of the lagging debris and dust was found on the spent fuel pond surface.
- On 6 October 2015, a head torch got loose from the elastic strap and fell into the Essential Service Water Pump suction header.
- On 4 October 2015, a broken fluorescent luminaire diffuser was found near the spent fuel storage pond.
- On 3 March 2015, a gas meter was found just inside the crank case door B5 of Emergency Diesel Generator (EDG 3) (1KJ-K02-3 EDG3)

- During Refuelling outage 13 (24 December 2014), a significant amount of foreign material was recovered from the shroud of Reactor Pressure Vessel head in the laydown area.
- On 8 June 2015, debris, such as small plastic bags, bits of hard plastic, small amounts of metallic fragments and a fabric type of material, were found inside a lubricating oil cooler.

Lack of rigorous implementation of the FME programme could challenge fuel integrity and equipment reliability.

**Recommendation:** The station should improve the implementation of its FME programme.

**IAEA Bases:**

SSR-2/2
7.11. An exclusion programme for foreign objects shall be implemented and monitored, and suitable arrangements shall be made for locking, tagging or otherwise securing isolation points for systems or components to ensure safety.

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

# 5. TECHNICAL SUPPORT

## 5.1. ORGANIZATION AND FUNCTIONS

The training programme for technical support personnel was developed using a systematic approach to training. The programme is accredited by an independent organization using industry recognized standards. This allows technical support staff to be trained on and be formally qualified for tasks they perform, and supports efficient qualification tracking. The team recognized this as good performance.

## 5.2. PERIODIC SAFETY REVIEW

The station's second Periodic Safety Review (PSR) process and scope were developed based on IAEA and other methodologies. A comprehensive process was used to organize the results of the PSR, and formal corrective actions were developed and are being formally tracked to completion. The station's safety case was updated in response to the PSR. The team recognized the station's PSR process as a good practice.

## 5.5. USE OF PSA

The station's Probabilistic Safety Analysis (PSA) is maintained by station staff as a "Living PSA" in that it is updated as needed to reflect station design and operation, and at least every 3 years. PSA is used extensively to inform both near-term and long-term operational and configuration decisions, and is reflected in the station's approach to online and outage risk assessment and management. The team recognized this as good performance.

## 5.7. PLANT MODIFICATION SYSTEM

The station has implemented an efficient yet thorough modification tracking and control process that makes effective use of the stations integrated computer system to ensure all modification related requirements are met. The system electronically links all items associated with a modification package including documents, work instructions, materials catalogue, tests, handovers, training requirements, maintenance strategy, and references. Milestone tracking, used throughout the modification planning and implementation, is clearly presented such that review and approval can be done online in a timely manner with transparency to all reviewers/approvers. The team recognized this as good performance.

Some examples of not controlling portable equipment related to heating and ventilation were observed by the team and resulted in a team suggestion to consider improving the application of existing station processes to control the use of portable equipment.

## 5.8. REACTOR CORE MANAGEMENT (REACTOR ENGINEERING)

A utility-developed neutronic and thermal-hydraulic code (PANTHER) is used to provide diverse checks on the output of industry standard software used for core design and operational support, and the team recognized this as good performance.

Reactor core management and overall station operations are supported by consistently high availability of computer systems. The station has maintained a dedicated Process Computing Group (PCG) from 1992; well before station start-up. This group is tasked with ensuring that a consistent, comprehensive approach is used to support engineering and maintenance of the station's important computer-based systems. This was particularly important because the station's design incorporated unprecedented use of computer-based monitoring and control systems. The continued use of a dedicated group has resulted in very high level of product quality as reflected by the number of issues not found prior to installation being almost zero. The team recognized this as good performance.

## DETAILED TECHNICAL SUPPORT FINDINGS

### 5.2. PERIODIC SAFETY REVIEW

**5.2(a) Good practice:** The station's Periodic Safety Review (PSR2) process is comprehensive and rigorous.

In the scope of its second Periodic Safety Review (PSR2) the station benchmarked its documented safety case against high level principles and requirements that are representative of international modern safety standards. The safety standards selected for the comparison comprise of three top tier IAEA safety standards identified as representing international best practice and consensus (Safety Fundamentals No. SF-1; Specific Safety Requirements No. SSR-2/1; Specific Safety Requirements No. SSR-2/2). In addition, the WENRA Reference Levels and the WENRA Statement on Safety Objectives for New Nuclear Power Plants were explicitly considered. Furthermore, review of lower level modern industry codes and standards was undertaken in each relevant technical discipline.

In order to ensure that the station's PSR2 has been conducted in line with world best practice, alignment with the IAEA Safety Factors presented in Specific Safety Guide No. SSG-25 was demonstrated using a tried and tested safety case methodology of Claims, Arguments and Evidence. A route map of the PSR2 alignment with the IAEA Safety Factors is documented in the PSR2 Head Document 'Adequacy of the Nuclear Safety Case Statement' which also presents a discussion of how the PSR2 process is aligned with the general objectives of the IAEA Global Assessment outlined in SSG-25. PSR3 will consider two additional Safety Factors covering the areas of radiological protection and decommissioning.

This thorough process for review of station performance against modern standards has resulted in a very comprehensive and well documented PSR supporting station continuous operation for next 10 years.

## 5.7. PLANT MODIFICATION SYSTEM

**5.7(1) Issue:** The station local instruction, "Additional Requirements at Sizewell B for Engineering Change Process", is not properly applied to the installation and control of some portable equipment used to augment station heating, ventilation, and air conditioning (HVAC).

The team noted the following:

- Two portable heaters in operation in the radiological chemistry laboratory were not installed under the station's portable equipment process. As a result, the heaters were not on the station's temporary equipment register. The heaters have been in place for several months and were installed to augment the room's HVAC system which was unable to maintain proper room temperature for the laboratory equipment in the room.
- Two portable cooling units in operation in the turbine building process sampling lab were not installed under the station's portable equipment or temporary modification processes. As a result, the coolers were not on the station's temporary equipment register. The coolers have been in place for about two years and were installed to provide room cooling pending upgrade of the room's HVAC system.
- Two portable heaters were installed in the hypo-chlorination transformer room to help reduce humidity when the transformers were not in operation. The heaters were not removed when the transformers were re-energized after the most recent transformer outage.

Installation of equipment outside required station controls or processes may have an adverse impact on equipment reliability or station operation.

**Suggestion:** The station should consider improving the application of existing station processes for use of portable equipment.

**IAEA Bases:**

SSR-2/2
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.

4.39 A modification programmes shall be established and implemented to ensure that all modifications are properly identified, specified, screened, designed, evaluated, authorized, implemented and recorded. Modification programmes shall cover structures, systems and components, operational limits and conditions, procedures, documents and the structure of the operating organization.

NS-G-2.3
2.11 Plant modifications should be performed in accordance with established procedures, with due consideration being given to quality assurance provisions.
2.13 The modifications should at all times be under the control of the plant management and should be managed in accordance with established procedures.

# 6. OPERATING EXPERIENCE FEEDBACK

## 6.1. ORGANIZATION AND FUNCTIONS

All permanent employees and contracted individuals are encouraged to identify and raise up issues within the condition reporting programme at Sizewell B. General station access training provides the knowledge and expectations of all employees, and they have sufficient access to computers, or can raise issues on a hard copy paper condition report, which will get entered into the Corrective Action Programme (CAP) and screened along with all of the other condition reports. In addition to general station access training on the CAP program, enhanced training is provided to team leaders, group heads, and CAP evaluators through the use of enhanced CAP Mentor Guides. Before they can perform their enhanced CAP duties, each individual must demonstrate understanding of the expectations of their enhanced CAP roles through a meeting with the site CAP Coordinator, or Deputy CAP Coordinator. The team considers this to be a good performance.

## 6.4. SCREENING OF OPERATING EXPERIENCE INFORMATION

Internal and external operating experience (OE) is screened by a dedicated site OE coordinator. This individual meets daily with their site counterparts through a series of regular conference calls. This collegial review ensures that operating experience that is important or pertinent to the station, the EDF-Energy fleet, or to the international community is identified and reported based on the significance of the issue. This is considered good performance in that this approach to OE screening improves the effectiveness, timeliness, and accuracy of the screening of relevant operating experience.

## 6.5. INVESTIGATION AND ANALYSIS

Although the station has demonstrated accuracy and proficiency at identifying organizational or programmatic causes for significant events, a weakness has been identified in the identification of the generic applicability of the issues or causes of those events. In some cases, the Extent of Condition is too narrowly focused, and the evaluation of the Extent of the Root Causes has not been properly performed. Failure to adequately identify the generic applicability of the events has the potential to delay rectifying organizational or programmatic issues that could contribute to or cause significant events. The team has made a suggestion in this area.

## 6.7. UTILIZATION AND DISSEMINATION OF OPERATING EXPERIENCE

The team has identified a good practice with regard to the utilization and dissemination of relevant operating experience at Sizewell. The station utilizes a valuable process and software known as the Organizational Learning Portal (OLP). The OLP is very effective at providing intuitive searching and sharing of pertinent operating experience to the station and the rest of the EDF-Energy fleet. This OLP is used in the daily pre-job briefs, engineering evaluations, training lesson plans and other processes at Sizewell. The team considered this to be a good practice.

## 6.8. TRENDING AND REVIEW OF OPERATING EXPERIENCE

The team noted some weaknesses in the trending of deficiencies, low level events, near misses and significant events at Sizewell B. This has resulted in the untimely correction of programmatic issues including some critical component failures on the emergency diesel starting air system, and with preventive maintenance programme weaknesses that are resulting in important safety system failures. A review of the departmental trend review boards revealed that for more than 90 per cent of the trends identified, no condition report or formal corrective action was taken to address the identified trend. Failure to identify or correct adverse trends will reduce the effectiveness of the corrective action programme in preventing more significant self-revealing events. The team recommends that the station enhances its corrective action programme trending process so that adverse trends once identified corrected.

## DETAILED OPERATING EXPERIENCE FEEDBACK FINDINGS

### 6.5. INVESTIGATION AND ANALYSIS

**6.5(1) Issue:** Root cause investigations and equipment failure investigations do not always adequately identify the generic applicability of significant events.

The following observations were made:

Extent of Condition and Extent of Cause were not properly identified in many recent Root Cause investigation reports. In some Root Cause Investigations, the Extent of Cause was not reviewed at all, eg:

- Extent of Cause was not evaluated in SACI 929590 Grouped Investigation of Recent Injuries
  - Extent of Cause was not evaluated in SACI 913666 Deluge of TG2 Operating Turbine
  - Extent of Cause was not evaluated in SACI 911865 Overflow of Hypochlorination Plant Hydrogen Disentrainment Tank and Bund
  - Extent of Cause was not evaluated in SACI 897343 Level 1 Safety Rules Event with Temporary Power Supply
  - Extent of Condition did not address the Root Cause in SACI 913666, in that the Root Cause was inadequate operating procedures that resulted in improper operation of the system, whereas the extent of condition discusses the uniqueness of the generator seals. The direct cause discusses the fact that the manual valve was shut.
- Although Equipment Failure Investigations (EFI) are performed for some significance level 3 critical component failures (CCF), current Corrective Action Programme (CAP) procedures do not require the identification of the generic applicability.
- Although Corrective Action Review Board (CARB) members receive initial training and a qualification prior to performing CARB duties, root cause investigation reports are approved by CARB without the proper identification of the extent of condition and extent of cause.
- Refresher training has not been performed with the Root Cause Investigators, or Corrective Action (CAP) coordinators.

Failure to properly identify the generic applicability of a significant event may prevent the adequate dissemination of the event, and may increase the potential of a recurrence of a similar event.

**Suggestion:** The station should consider enhancing its root cause analyses to ensure that generic applicability of significant events is always adequately identified.

**IAEA Bases:**

SSR–2/2
5.28 Events with safety implications shall be investigated in accordance with their actual or potential significance. Events with significant implications for safety shall be investigated to identify their direct and root causes, including causes relating to equipment design, operation and maintenance, or to human and organizational factors.

NS-G-2.11
2.4 The investigation and reporting of events contribute to improvements in nuclear safety and have the following objectives:

- To assess the generic applicability of events
- To prevent the recurrence of similar events.

Appendix III.3 Training (both initial and refresher) should be provided for the staff who might take part in an investigation. This should include training in investigation techniques, documentation needs, witness interviews, conflict resolution and dealing with confidentiality issues.

## 6.7. UTILIZATION AND DISSEMINATION OF OPERATING EXPERIENCE

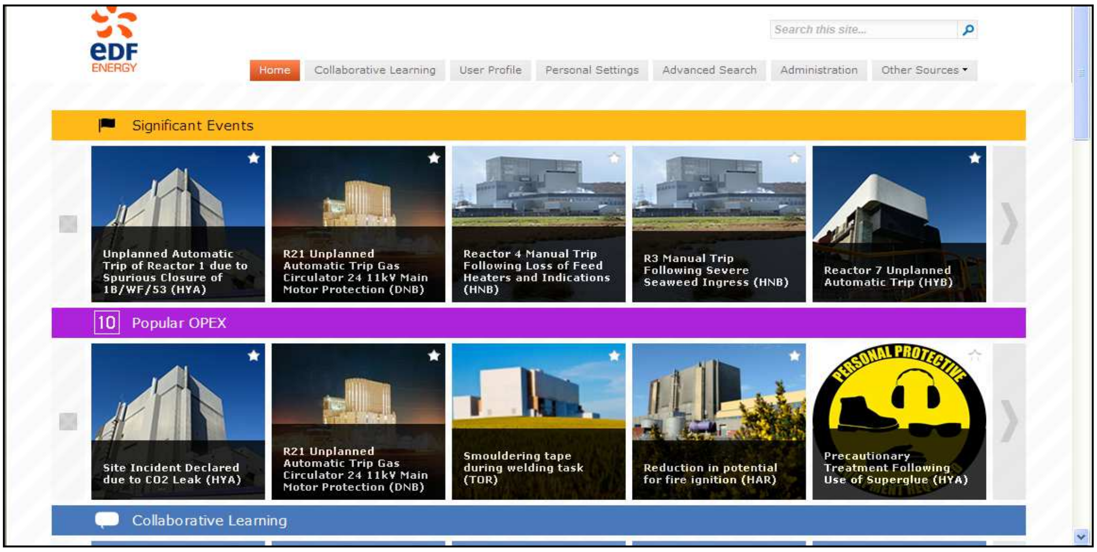
**6.7(a) Good Practice:** Organizational Learning Portal

The Organizational Learning Portal has been developed to enable all internal and external operating experience to be available in one system which can be reviewed by all personnel on-site.

The system enables rapid entry of events such as reactor trips which can then be commented on by all stations in the EDF-Energy nuclear fleet.

Individuals can set up favourite categories so that relevant events are sent directly to them by e-mail daily, weekly or monthly basis with hyperlinks to the OPEX report. They can also change their home page so that events are listed in the order of significance appropriate to each person.

The Organizational Learning Portal is a cross fleet operational experience database. Any one on site with computer access can access the database to view fleet, international and industry operating experience.




Results: During May 2015 the station saw more than 500 unique individuals accessing the database to review the Operating Experience.

## 6.8. TRENDING AND REVIEW OF OPERATING EXPERIENCE

**6.8(1) Issue:** Corrective action programme trending is not consistently performed across the station and some important adverse trends are not identified and corrected.

The following observations were made:

- An adverse trend in High Integrity Control System (HICS) events that resulted in unplanned LCO entries was identified within the past year. No condition report was written to document this trend and subsequently, no CAP investigation was performed to identify the causes of the adverse trend.
- An adverse trend of equipment failures caused by preventive maintenance issues was identified by the OSART team during the trending of important equipment failures, no condition report was initiated, and no CAP investigation was performed to address this trend (eg. demonstrated by CR 00913012; 00941784, 00901271).
- Three previous failures of related diesel starting solenoid valves caused by problems with the gaskets occurred prior to an event which placed the plant into an unplanned shutdown LCO (ref CR 959278). No CR was written to document any of the previous events, therefore trending of this common failure was not performed prior to this event. The gasket kit (Stock Code/CatID number 415057) for Emergency Diesel Starting Air System solenoid valve 1KJ-4723 had been issued out 4 times for the equivalent valve (Stock Code/CatID 412960) on the emergency diesel generators since the beginning of 2013, for similar failures. The system engineer had been aware of these failures, but he had not written CRs, only work orders until the station got placed into a 72 hour shutdown LCO and 24 hour action statement.
- Although Operations trending in 2015 identified configuration control events as a trend, no condition report was written and no CAP investigation was performed.
- Departmental trending does not result in Condition Reports (CR) or trend investigations for more than 90 per cent of all gaps identified at the site.
- A large number (17%) of causal factor codes are “Unknown”, “Other”, or “Not Coded”
- Many departments have only started performing formal trend review boards within the past year.

Failure to adequately trend and analyse events will reduce the effectiveness of the corrective action programme at preventing more significant events

**Recommendation:** The station should enhance its corrective action programme trending so that adverse trends are timely and consistently identified and corrected.

**IAEA Bases:**

SSR-2/2
5.28. Events with safety implications shall be investigated in accordance with their actual or potential significance. Events with significant implications for safety shall be investigated to identify their direct and root causes, including causes relating to equipment design, operation and maintenance, or to human and organizational factors.

5.29 Information on operating experience shall be examined by competent persons for any precursors to, or trends in, adverse conditions for safety, so that any necessary corrective actions can be taken before serious conditions arise.

NS-G-2.11

6.5 Trending should be used to analyse the performance of various work groups, to identify those factors that result in either less than desired or better than expected performance. Follow-up investigations should be performed to gain a better understanding of why an abnormal trend is occurring so as to determine the causal and contributing factors.

6.10 Once an abnormal trend has been identified it should be treated as an event, and the established deficiency reporting programme should be used to initiate an appropriate analysis and to determine whether the trend is identifying adverse performance. The level of the analysis should be based on the significance of the trend and its potential consequences. A thorough root cause investigation can be made so as to identify causal and contributing factors to explain why a trend is occurring. Corrective actions should be focused on addressing the causes and should be incorporated into the organization's process or programme for corrective actions. Subsequent follow-up actions should be taken to verify that the adverse trend has been corrected or to modify the original corrective actions.

6.11 The investigation should then be focused on these more frequent factors, thereby increasing the probability that the actual (root) cause(s) of the adverse trend will be identified

# 7. RADIATION PROTECTION

## 7.3 RADIATION WORK CONTROL

In general, activities in the Radiological Controlled Area (RCA) are performed in accordance with clear rules and the presence of a strong, well-qualified Radiological Protection (RP) staff. This delivers good radiological protection results in terms of contamination control. However the station's practices related to low source term activities does not always promote progress in improving contamination control. The team noted that certain practices in the field do not reflect the generally good standard of radiological protection. As an example, it is noted that the rate of contamination events was increasing throughout this year. The team made a suggestion in this area.

## 7.4 CONTROL OF OCCUPATIONAL EXPOSURE

At the station, all activities in the RCA are subject to radiological risk assessments to ensure that radiation doses are optimised. Since the beginning of operation, the station has typically achieved good results in terms of reducing radiation exposure; particularly during outages and other significant projects. However, the team noted that for medium risk activities when the station is at power, there was limited interaction between radiological protection staff and other work groups to establish challenging dose goals and to track progress of radiation exposure. In a small number of jobs, radiation doses exceeded the initial estimates made by the radiological protection staff. This was the case for the work done to address emergent defects associated with an RHR pump that occurred in the first half of this year. The team identified opportunities for improved planning and engagement between radiological protection and other work groups, and made a suggestion in this area.

## DETAILED RADIATION PROTECTION FINDINGS

### 7.3. RADIATION WORK CONTROL

**7.3(1) Issue:** The station practices applied in the RCA are not rigorous enough to support continuous contamination control improvement.

The station has a very low threshold to control station contamination and has very good performance in this area. However during the mission, the team identified some gaps which may prevent the station making further improvements. Examples of such facts are:

- Currently, 31 low level contamination events have been recorded since the last outage (5/12/2014). The rate of those contamination events is increasing.
- In only 38.7 % of contamination events the contaminated persons had entered a Contamination Controlled Area (C2). The majority of contamination events occur in uncontaminated areas of the RCA.
- During an iodine filter replacement, the old iodine filter was placed with the rest of the RP Technician's equipment at the end of the job. Segregation of clean and potentially contaminated equipment was not adequate.
- The station has a breakdown of Personal Contamination Event rate by Department, however there is currently no action plan developed to drive the rate lower.
- Contamination was detected on a worker after using a contaminated FME cover on the roof of the Auxiliary Building. The root cause was not determined.
- An RP Technician was contaminated in the Radwaste Building although he had not entered a C2 Area (7/10/15). The root cause was not determined.
- Before released as conventional waste the content of the bags from 'non-radioactive material' (Green stream waste) is only checked externally. This check doesn't systematically ensure that prohibited materials (for example items with radioactive marking) are not inside the bag.
- Green stream waste sacks are checked for contamination directly on the floor. The work position is not very ergonomic and no protection is used in case the bag or contents are contaminated.
- Approximately 25% of the observed green stream sacks did not meet the release acceptance criteria and had to be classified as radioactive waste.
- At the RCA boundary a part of a refrigeration unit, 1GK-E14 was checked for contamination. The arrangements for the control of such materials brought to the RCA boundary assume that the materials to be released are not contaminated.

By not using rigorous practices in the RCA the station may reduce the opportunity to further improve contamination control performance.

**Suggestion:** The station should consider developing more rigorous practices in the RCA to support continuous contamination control improvement.

**IAEA Bases:**

RS-G-1.1

4.22. Experience with a particular situation sometimes indicates a need to review procedures and performance. This experience may be qualitative (e.g. the observation that the frequency of occurrence of minor contamination may have increased) or quantitative (e.g. a trend in the results of monitoring programmes). The use of quantitative experience can be assisted by the application of investigation levels to monitoring results for individuals and workplaces. Investigation levels are one type of reference level (see Section 2). They are to be used in a retrospective sense, and should not therefore be confused with dose constraints. If an investigation level is exceeded, then this should prompt a review of the situation to determine the causes. This review should have the objectives of extracting appropriate lessons for any future operations and determining whether additional measures are needed to improve the current protection arrangements.

4.23. Investigation levels should be seen as important tools for use by management and should therefore be defined by management at the planning stage of activities; they may be revised on the basis of operational experience. Regulatory authorities may also wish to establish generic investigation levels in terms of individual dose for regulatory purposes.

5.18. The BSS (Ref. [2], para. I.21) state that:

“Registrants and licensees shall designate as a controlled area any area in which specific protective measures or safety provisions are or could be required for:

(a) controlling normal exposures or preventing the spread of contamination during normal working conditions; and

(b) preventing or limiting the extent of potential exposures.”

5.23. The BSS (Ref. [2], para. I.23) state that “Registrants and licensees shall:

(h) periodically review conditions to determine the possible need to revise the protection measures or safety provisions, or the boundaries of controlled areas.

5.41. Thus, a programme of monitoring may be used for a number of specific purposes, depending on the nature and extent of the practice. These purposes may include:

(a) Confirmation of good working practices (e.g. the adequacy of supervision and training) and engineering standards;

(d) Evaluation and development of operating procedures from review of collected monitoring data for individuals and groups (such data may be used to identify both good and bad features of operating procedures and design characteristics, and thereby contribute to the development of safer radiation working practices);

5.60. The results and findings of workplace monitoring should be recorded (see para. 5.86), and made available to line management and employees (through their representatives if appropriate). This information should be used in support of pre- and post-job evaluations, job planning, contamination control and management of radiological control operations. Significant changes in monitoring results should be identified and trends analysed periodically. Corrective actions should be taken as necessary.

NS-G-2.7

3.13. Before items are removed from any contamination zone, and in any case before they are removed from controlled areas, they are required to be monitored as appropriate (Ref. [2], para. I.23) and suitable measures should be taken to avoid undue radiation hazards.

## 7.4. CONTROL OF OCCUPATIONAL EXPOSURE

**7.4(1) Issue:** The station process for the setting of goals and tracking of medium risk work dose does not involve all relevant work groups to ensure the optimisation of doses.

The following observations were made:

- For work at power, radiological goals are established by the RP department based on the work that is supposed to be performed. There is no dedicated meeting or challenge with other Departments to establish dose goals.
- Tier 1 dose estimates are set in November of the preceding year. These estimates are set exclusively by RP department without systematic input from other departments. This does not allow the dose estimate to be reviewed by work groups, in order to optimise them.
- In the preparation phases, there is seldom interaction between RP and other work groups in order to analyse the risks and to optimize doses.
- Emergent defects associated with RHR pump maintenance required additional Maintenance and Operation resources in higher dose rate areas. At no stage were there discussions between RP and the work groups to ensure optimisation of doses.
- Sizewell B outage doses compared to similar stations were in the first quartile in 2014, however for the same benchmark Sizewell B at power doses were in third quartile.
- There is a lack of preparation with other work groups before the more significant jobs are carried out at power. An example is the planning & preparation of active waste container loading (CR # 957678 reference). At the end of the operation the waste container was found with a number of filters different from those initially specified. This necessitated the removal of the majority of the filters in order to count them again and therefore resulted in a collective dose higher than expected.

By not involving all relevant work groups in the setting of goals and tracking of dose, for medium risk work, doses may not be consistently optimized.

**Suggestion:** The station should consider enhancing the process for setting of goals and tracking of medium risk work dose to ensure that all relevant work groups are involved in the optimisation of doses.

**IAEA Bases:**

SSR-2/2
5.11. The radiation protection programme shall ensure that for all operational states, doses due to exposure to ionizing radiation in the plant or doses due to any planned radioactive releases (discharges) from the plant are kept below authorized limits and are as low as reasonably achievable.

RS-G-1.1
4.6. Optimization of protection in operation is a process that begins at the planning stage and continues through the stages of scheduling, preparation, implementation and feedback. This process of optimization through work management is applied in order to keep exposure levels

under review, to ensure that they are as low as reasonably achievable [15]. The elaboration of a radiation protection programme, adapted to the specific exposure situations, is an essential element of work management.

4.19. To apply the optimization principle, individual doses should be assessed at the design and planning stages, and it is these predicted individual doses for the various options that should be compared with the appropriate dose constraint. Options predicted to give doses below the dose constraint should be considered further; those predicted to give doses above the dose constraint would normally be rejected. Dose constraints should not be used retrospectively to check compliance with protection requirements.

4.20. Dose constraints should be used prospectively in optimizing radiation protection in various situations encountered in planning and executing tasks, and in designing facilities or equipment. They should therefore be set on a case-by-case basis according to the specific characteristics of the exposure situation. Since dose constraints are source related, the source to which they relate should be specified. Dose constraints may be set by management, in consultation with those involved in the exposure situation. Regulatory authorities may use them in a generic way — for categories of similar sources, practices or tasks — or specifically, in licensing individual sources, practices or tasks. The establishment of constraints may be the result of interaction between the regulatory authority, the affected operators and, where appropriate, workers' representatives. As a general rule, it would be more appropriate for the regulator to encourage the development of constraints for occupational exposure within particular industries and organizational groupings, subject to regulatory oversight, than to stipulate specific values of constraints.

4.21. The process of deriving a dose constraint for any specific situation should include a review of operating experience and feedback from similar situations if possible, and considerations of economic, social and technical factors. For occupational exposure, the experience with well managed operations is of particular importance in setting constraints, as it should be for implementing the optimization principle in general. National surveys or international databases, delivering a large amount of experience with exposures related to specific operations, can be used in setting constraints.

NS-G-2.7

3.39. The planning of work to be undertaken in controlled areas where it is possible that levels of radiation or contamination may be significant is an important means of keeping doses as low as reasonably achievable and should be considered. The radiation protection group should take part in the planning of any activities that might entail significant doses and should advise on the conditions under which work can be undertaken in radiation zones and contamination zones.

3.40. Such work planning should include the provision of written procedures as appropriate. Matters that should be considered in the planning of work include:

(a) information on similar work completed previously;

(b) The intended starting time, the expected duration and the personnel resources necessary;

(c) the plant's operational state (cold or hot shutdown, operation at full power or decreased power);

(d) other activities in the same area or in a remote area of the plant that may interfere with the work or may require the work to be conducted in a particular manner;

(e) the need for preparation for and assistance in operations (such as isolation of the process, construction of scaffolding or insulation work);

(f) the need for protective clothing and a listing of tools to be used;

(g) communication procedures for ensuring supervisory control and co-ordination;

(h) the handling of waste arising;

(i) requirements and recommendations for industrial safety in general.

3.41. Responsibilities with regard to interfaces between different working teams should be clearly identified. A responsible work supervisor should be designated who should ensure that all participants have received training, including training in radiation protection, as needed for the type of work and the conditions in which the work will be undertaken.

# 8. CHEMISTRY

## 8.2. CHEMISTRY PROGRAMME

The station has a qualification process for labelling, storage and use of any chemicals. The user has to complete an application form and provide the safety data sheet and information about the activity. A chemist is responsible for managing the Control of Substances Hazardous to Health (COSHH) process. In parallel, a sample of the chemical can be analysed for impurities. If both processes are positive, the user is allowed to purchase the chemical and to use it for the intended activity. However, chemicals and substances are not labelled according to the area in which they are permitted to be used.

The team recognized that the handling of chemicals is not consistently applied across the station to ensure that the use of chemical substances and reagents do not always have an adverse effect on station equipment or industrial safety. The team made a suggestion in this area.

The secondary circuit pH was successfully increased in three steps from 9.3 to 10 to minimize the iron concentration. Iron concentration is monitored by daily trending. Every year, when the steam generators are cleaned, sludge is analysed and trended. The result in reduction of iron is significant, which the team identified as a good performance.

The Chemistry staff takes part in international round robin tests to ensure the quality of the analyses. All chemistry analyses data are documented in a Laboratory Information Management System (LIMS) which is the important source for quality control and trending. By trending all results of analyses, deviations in chemistry parameters typically are discovered immediately and corrective measures are typically promptly initiated. The Chemistry staff reacts early to deviations long before action limits are reached. This demonstrates an excellent understanding of safety culture. The team identified this as a good performance.

For any new chemicals there is a qualification process. The user has to complete an application form and provide the Material Safety Data Sheet (MSDS) and information about the activity. The station staff is required always to use the current version of the MSDS, so the station found an easy and user-friendly way to be up to date. All MSDS for the chemicals used in the station are delivered in a way which ensures that all MSDS's are always up to date. Data are provided to customers via a secure web site. The Team recognized this as a good performance.

## DETAILED CHEMISTRY FINDINGS

8.2. CHEMISTRY PROGRAMME

**8.2(1) Issue:** The station policy for handling chemicals is not always consistently applied in order to avoid the potential of chemical substances and reagents having an adverse effect on station equipment or industrial safety.

During the mission the team observed the following facts:

- Two bubblers for Tritium sampling were incompletely labelled. The description of the contents (diluted nitric acid) was missing.
- There is a problem in affixing labels to the rubber solvent bottles. The labels do not stick to the surface of the bottles.
- Two bottles of methanol out of 76 in the radiochemistry laboratory were not correctly labelled (only labelled flammable and hazardous); the mandatory toxic label was missing.
- A box containing graphite was found in a cabinet in the workshop. The label on the box was dirty and unreadable.
- A box containing petroleum jelly was labelled three times: the original label from the supplier said the shelf life was 3 years from purchase, the other given by the station said it was valid until 2020. Additionally a third label added by the corporate depot showed the warning for harmful and toxic chemicals which is wrong in this instance.
- The station has a formal process for material compatibility control. However, chemicals and substances are not labelled according to the area in which they are permitted to be used.
- The station has self-identified deficiencies in handling chemicals; for examples in 2014 there were 6 relevant operational events.
- A new cabinet was filled with flammable chemicals but was not labelled, even though it was registered on the stations chemical storage log (cabinet 140).
- One out of 14 cabinets (cabinet 59) in the Main Store is labelled “flammable” but contained both flammable and corrosive chemicals.

Without having a consistently applied policy for handling chemicals, the station cannot ensure that the use of chemical substances and reagents may not adversely affect station equipment or industrial safety.

**Suggestion:** The station should consider enhancing the application of its policy for handling chemicals to ensure that the use of chemical substances and reagents does not have an adverse effect on station equipment or industrial safety.

**IAEA Bases:**

SSR-2/2
7.17: “The use of chemicals in the plant, including chemicals brought in by contractors, shall be kept under close control. The appropriate control measures shall be put in place to ensure that the use of chemical substances and reagents does not adversely affect equipment or lead to its degradation.”

SSG-13
9.9: “Chemicals and substances should be labelled according to the area in which they are permitted to be used, so that they can be clearly identified. The label should indicate the shelf life of the material.”

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

Safety in the use of chemicals at work – ILO; 4.2.5: “Each container or layer of packaging should be marked. The particulars should always be visible on the container or package during each stage of the supply and use of the chemicals.”

Safety in the use of chemicals at work – ILO; 4.3.2: “The purpose of the label is to give essential information on:

a) the classification of the chemical;

b) its hazards;

c) the precautions to be observed.

The information should refer to both acute and chronic exposure hazards.”

# 9. EMERGENCY PREPAREDNESS AND RESPONSE

## 9.1. ORGANIZATION AND FUNCTIONS

The station has performed a hazard assessment for emergency planning purposes. The hazard assessment selected design basis accidents as a basis for the emergency plans. In addition, the station is considering the concept of extendibility to cover beyond design basis accidents. The team has made a suggestion to consider benchmarking the hazard assessment against the approach used in other countries.

The team observed that the "EP Focus Index" was the lowest in the EDF-Energy fleet in May 2015. This has since showed constant improvement up to now. The separate "EP scorecard", which allows corporate management to compare the performance between the sites, is no longer being updated at Sizewell B. The use of two separate indices is due to a mismatch between the generic fleet requirements and the way Sizewell B can meet those requirements. The team encourages the station to resolve those issues and continue to monitor performance of the emergency preparedness programme at Sizewell B.

## 9.2. EMERGENCY RESPONSE

When an emergency is declared, the Rapid Reach pager system for emergency recall is used to promptly notify the personnel on duty and the public authorities. The system failed repeatedly to reach all persons on duty during tests, due to network coverage in the local area. The station is encouraged to continue the investigation of this problem and to find a solution.

The Sizewell B Emergency Manual describes the conditions for the classification of an emergency. Some conditions refer to Site Operating Instruction SOI 8.1 – Critical Safety Function Monitoring, which uses a classification system based on station parameters. This meets the intent of the IAEA guidance. However, the Emergency Manual includes other conditions that are not specific to the Sizewell B station and may not trigger the appropriate classification unambiguously. Examples include "Emergency Services personnel are required to make access to a Radiological Controlled Area (RCA) in significant numbers", "A significant increase in site radiation levels is observed", and "An increase in containment radiological and/or environmental conditions is observed". The station is encouraged to make all conditions for the classification of an emergency more quantitative rather than qualitative and specific to the Sizewell B station.

The station has telephone land lines with backup and redundancy at all emergency facilities. It also has mobile satellite phones that can connect with the corporate Central Emergency Support Centre. The local police have their own satellite phones, but the satellite phone numbers have not been shared between organizations. The station is encouraged to share all phone numbers, including satellite phones, between organizations involved in the response to an emergency.

The process used by the station to assess off-site radiological consequences, transmit data and recommendations to the public authorities has not been optimized to reduce unnecessary delays. The team made a suggestion in this area.

The habitability criterion for Muster Points is 100 μSv/h (based on the Electronic Personal Dosimeter alarm setting), but the Emergency Handbook, Section 10.3.6 sets the on-site survey evacuation criterion at 30 000 μSv/h, while Section 10.10.2 sets the on-site dose rate limit for all staff not actively engaged on station control or damage control to 300 – 3 000 μSv/h. The station is encouraged to ensure that the habitability criteria are consistent across procedures and policy documents.

Dose to emergency workers above 100 mSv, up to 500 mSv are approved for life saving operations by the Emergency Controller. The station doesn't have a documented or pre-established briefing for emergency workers who could receive doses in excess of 50 mSv. The position of the station is that emergency workers have been trained and are aware of the risks. The team encourages the station to ensure that emergency workers who could receive a dose in excess of 50 mSv are always volunteers who have been clearly and comprehensively informed of associated health risks.

## 9.3. EMERGENCY PREPAREDNESS

The station has a well-developed exercise evaluation program, but the evaluation report does not list the facts used to develop the evaluation. The evaluation report would be more credible if each finding mentioned in the report was based on well supported observations. The team made an encouragement in this area.

The station created a very comprehensive list of emergency exercise constraints that must be exercised every five years. The team recognized a good practice in this area.

## DETAILED EMERGENCY PREPAREDNESS AND RESPONSE FINDINGS

### 9.1. ORGANIZATION AND FUNCTIONS

**9.1(1) Issue:** The station has not benchmarked its methodology for conducting the hazard assessment required within the IAEA Safety Standard for emergency planning against the approach applied in other countries.

The team noted that the station has invested considerable resources in an Emergency Response Centre and in Emergency Backup Equipment that will help mitigate the progression and consequences of beyond design basis accidents.

However, the team has made the following observations:

- The current planning basis for nuclear and radiological accidents is described in “REPPIR Report of Assessment for Sizewell B 2014”; Section 3.1.13 n) and Appendix A. The planning basis is further explained in document “The REPPIR Reference Accident – Additional Information for Sizewell B”. Following a consideration of the likelihood and consequences of the entire range of fault sequences examined in the Station’s Safety Case (including events of very low probability and outside the design basis of the station), the most severe design basis faults were selected as the basis for defining detailed off-site plans. The UK approach is for these detailed plans to provide the basis for a more extensive response to even less likely but potentially more severe consequences (what the UK refers to as “extendibility”). This approach meets UK regulations but is different to that used in most other countries who base plans on events involving severe damage to the reactor fuel.
- The Emergency Control Centre and the Technical Support Centre located in the Auxiliary Shutdown Building do not have equipment to check personnel for contamination (contamination monitor or portal monitor) before they come into the building during an emergency. There is a single personal electronic dosimeter in the Emergency Control Centre, a whole building intake air monitoring but no local ambient gamma detector or air sampler. In contrast, the backup Emergency Control Centre at Sizewell A has the appropriate suite of detection equipment. The Emergency Response Centre is in the process of acquiring the appropriate detection equipment, but already has a portal monitor and decontamination facilities.

Without benchmarking its methodology to conducting the hazard assessment for Sizewell B’s emergency planning against the methodology used by similar stations in other countries, the station may not understand the reasons for differences and may not consider whether changes are desirable.

**Suggestion**: The station should consider benchmarking its methodology to conducting emergency planning hazard assessment against the methodology used by similar stations in other countries to ensure that events involving severe damage to the reactor fuel are adequately addressed in emergency plans.

**IAEA Bases:**

GSR Part 7
4.18: “Hazards identified and potential consequences of an emergency shall be assessed to provide a basis for establishing arrangements for preparedness and response for a nuclear or radiological emergency. These arrangements shall be commensurate with the hazards identified and the potential consequences of an emergency.”

4.19: “For the purposes of these safety requirements, assessed hazards are grouped in accordance with the emergency preparedness categories shown in Table I. The five emergency preparedness categories (hereinafter referred to as ‘categories’) in Table I establish the basis for a graded approach to the application of these requirements and for developing generically justified and optimized arrangements for preparedness and response for a nuclear or radiological emergency.

TABLE I. EMERGENCY PREPAREDNESS CATEGORIES

| Category | Description |
|---|---|
| I | Facilities, such as nuclear power plants, for which on-site events (including those not considered in the design – this includes events that are beyond the design basis accidents and, as appropriate, conditions that are beyond design extension conditions) are postulated that could give rise to severe deterministic effects off the site that warrant precautionary urgent protective actions, urgent protective actions or early protective actions, and other response actions to achieve the goals of emergency response in accordance with international standards, or for which such events have occurred in similar facilities. |

4.20: “The government shall ensure that for facilities and activities, a hazard assessment on the basis of a graded approach is performed. The hazard assessment shall include consideration of:

(a) events that could affect the facility or activity, including events of very low probability and events not considered in the design;”

EPR-NPP 2013
4: “The sizes of the zones and distances can be established based on specific analysis of the nuclear power plant, as long as releases that are representative of those expected for an emergency involving severe damage to the reactor fuel are considered, as illustrated in Appendix 1.”

## 9.2. EMERGENCY RESPONSE

**9.2(1) Issue**: The process used to assess off-site radiological consequences during a nuclear emergency is not optimized to reduce unnecessary delays when providing data and recommendations to public authorities.

The following observations were made:

- There is a gap between the expectations of public authorities regarding the timing of response actions, and the clarity of the expectations of the station. For example, the exercise report for Exercise Tiger (25th February 2015) gives a target time of 70 minutes after the site emergency warning signal is activated for the first written counter measure advice to be handed to the Police liaison at the Emergency Control Centre in the Emergency Response Centre building, instead of giving 70 minutes to update the standing advice automatically already implemented within 30 minutes in accordance with the local authorities. The station target time for the first off-site survey results is 90 minutes. In contrast, the Sizewell off Site Emergency Plan assumes that an agreement on off-site protective actions will be achieved within 30 minutes of the declaration of an emergency, and initial radiation monitoring results at the site boundary or near the site will be available within 60 minutes.
- The station currently uses the site boundary ambient gamma dose rate monitoring stations, in combination with other station conditions, to trigger the prompt declaration of an off-site emergency. However, the station could also use these measurements to measure the extent of the radiation contamination around the site by promptly making these measurements available to the public authorities. The alarms and dose rate readings are available on-line at the station and the Central Emergency Support Centre, but they are not available on-line at the Strategic Coordination Centre in Ipswich.
- There is no operational intervention level for gamma dose rate measurements that triggers urgent protective actions. Instead, the Central Emergency Support Centre uses the gamma dose rate measurements, along with wind direction from the on-site meteorological data, to estimate the source term, and subsequently calculate the effective dose. This is then compared with the Emergency Response Level for triggering protective actions in the population. This complex chain of calculations takes time and may delay the response.
- The station has not implemented pre-established operational criteria in the most efficient manner. For example, the only operational intervention levels are associated with gross beta measurements of air samples; taking and counting air samples takes time. The station also performs swab measurements of ground contamination but there is no operational intervention level based on ground contamination measurements that triggers urgent protective actions.

Without improving the process used to assess off-site consequences during a nuclear emergency, unnecessary delays may arise in providing data and recommendations to public authorities.

**Suggestion**: The station should consider optimizing the process applied for assessment of off-site radiological consequences by using operational intervention levels during the early phase of an emergency, in order to avoid unnecessary delays in providing data and recommendation to public authorities.

**IAEA Bases:**

GSR Part 7
5.34: "These arrangements as stated in para. 5.32 shall include the use of pre-established operational criteria in accordance with the protection strategy (see para. 4.28(4)) and provision for access to instruments displaying or measuring those parameters that can readily be measured or observed in a nuclear or radiological emergency."

5.40: "Within emergency planning zones and emergency planning distances, arrangements shall be made for timely monitoring and assessment of contamination, radioactive releases and exposure doses for the purpose of deciding on or adjusting the protective actions and other response actions that have to be taken or are being taken. These arrangements shall include the use of pre-established operational criteria in accordance with the protection strategy (see para. 4.28(4))."

EPR-NPP 2013
2.2: "Upon identification of condition leading to severe fuel damage (i.e. General Emergency) take the following steps, as illustrated in FIG 1:

Step 1. Within 15 minutes, the shift supervisor declares a General Emergency on the basis of predetermined conditions and instrument readings in the nuclear power plant within the classification system (EALs exceeded).

Step 2. Within 30 minutes, the shift supervisor notifies the off-site decision maker(s) responsible for protecting the public within the PAZ, UPZ, EPD, and ICPD.

Step 3. Within 45 minutes, the off-site decision maker(s) starts implementing the urgent protective actions for the public, as detailed in Section 5."

EPR-NPP 2013
2.4: "Networks of automated environmental monitoring stations can also be useful in directing monitoring teams, and when combined with operational intervention levels (OILs), in identifying areas warranting evacuation, relocation and food restrictions following a release. In all cases, tools used as a basis for urgent protective actions must be integrated into decision-making systems in such a way that their use will not delay the implementation of urgent protective actions, especially for making decisions concerning those that need to be taken before or shortly after release to be most effective."

EPR-NPP 2013
8.1: "Operational criteria need to be developed in advance in order to trigger response actions based on environmental measurements and samples. Procedures to revise default OILs needs to be developed according to the prevailing circumstances. When criteria are developed during an emergency they are not trusted by the public."

## 9.3. EMERGENCY PREPAREDNESS

**9.3(a) Good Practice:** The range of emergency exercise constraints that are tracked is very comprehensive

In conformity with IAEA standards, the station implemented an exercise programme that covers all response functions required during an emergency, and tests the associated exercise objectives and the emergency personnel regularly.

In addition, the station created a comprehensive list of exercise constraints that must be tested over a five year period:

- Normal working hours; outside working hours
- Normal operation; outage
- Mustering with automatic system; mustering with manual system
- Alerting with automatic system; alerting with cascade of telephone calls
- With main communication network available; without main communication network available
- With public address system available; without public address system available
- With Main Control Room available; without Main Control Room available
- With Emergency Control Centre available; without Emergency Control Centre available
- With Access Control Point available; without Access Control Point available
- With Shift Manager; without Shift Manager
- With Emergency Controller; without Emergency Controller
- With external services (police liaison) at Emergency Control Centre; without external services
- Fire with off-site fire service support; without off-site fire service support
- Security event with off-site police service support; without off-site police service support
- Release monitoring with off-site survey available; without off-site survey available
- With electrical grid available; without electrical grid available
- Slow reactor depressurization; Fast reactor depressurization
- With contained accident; with release to the environment
- With high radiation environment for emergency response teams; without high radiation environment

Tracking such a comprehensive list of constraints ensures that the emergency plan is tested under the full range of conditions that could arise during an emergency.

Result: By implementing this process, the station identified corrective actions to cover gaps in the emergency arrangements that would not have been detected otherwise.
Some examples where this has been beneficial to the station include the following:

- Exercising lack of an emergency Controller highlighted a very high burden of work falling on the Shift Manager and subsequently led to the simplification of the Shift

Manager first hour response (e.g. introduction of snatch-pack, pre-arranged notification messages agreed with police)

- Exercising loss of ACP availability led to modification of the alternate facility to enable it to run both as a forward control point and a fully operational ACP
- Exercising loss of electronic muster system led to the introduction of the manual tally system which allows rapid manual accountability of personnel. This is also frequently practiced in exercises and has led to an efficient and well-disciplined manual system that is now seen by the UK regulator as industry best practice
- Exercising loss of automatic notification system raised the issue of increased burden on the Shift Manager within the first hour in order to carry out notifications. The Cascade officer was introduced as a result of this, thus releasing the Shift Manager from the requirement to follow carry out manual notifications. The cascade officer now also verifies that notifications are complete either via the automatic system or through manual activation.
- Exercising with external emergency services has led to more coherent planning between Station and those services, including collaborative exercises and the setting up of a specific emergency services forum to discuss issues and improvements to response.

# 10. ACCIDENT MANAGEMENT

## 10.1. ORGANIZATION AND FUNCTIONS

The station's approach to severe accident management differs from the approach developed by the PWR Owner's Group by investing primary responsibility for decision making in the control room using severe accident procedures, rather than in the Technical Support Centre (TSC) using severe accident guidelines. However, room still exists for the development of additional guidance material for the TSC to enhance its ability to support the control room with technical advice during the course of a severe accident. The station has identified several examples of where additional TSC guidance could be developed, and the team encourages the station to continue its efforts to develop this guidance.

Operators are trained on the severe accident procedure using the simulator as a classroom. The simulator is frozen at the onset of core damage where the simulator software may become unstable, and the instructor talks through and walks through the procedures in the simulator with the operating shift on training. This also serves as a validation process to ensure that all the instructions in the severe accident procedure are correct, understandable and can be implemented from the control room panels by the operators. The team considers this as a good performance.

## 10.2. OVERVIEW OF THE SEVERE ACCIDENT MANAGEMENT PROGRAMME

The bases document for the severe accident procedure does not comprehensively discuss and link some of the severe accident management actions to its technical basis. The team made a suggestion in this area.

## 10.4. DEVELOPMENT OF PROCEDURES AND GUIDELINES

The severe accident management procedures do not specifically address all station operating states or provide guidance for the prioritisation of fuel storage pond accidents. The team made a suggestion in this area.

## 10.5. PLANT EMERGENCY ARRANGEMENTS WITH RESPECT TO SAM

The station does not have formal arrangements in place to obtain technical support from the plant vendor or other equivalent international support organizations during a severe accident. The team encourages the station to consider enhancing its off-site technical support mechanisms and to ensure that any support organizations are familiar with the station's design features that are relevant to severe accident management.

## DETAILED ACCIDENT MANAGEMENT FINDINGS

### 10.2. OVERVIEW OF THE SEVERE ACCIDENT MANAGEMENT PROGRAMME

**10.2(1) Issue**: The bases document for the severe accident procedure does not comprehensively discuss and link some of the severe accident management actions to its technical basis.

The team observed the following:

- Step 17.5 in the severe accident procedure SOI-8.8 instructs the operators to dump steam from a ruptured steam generator after the core has been reflooded, in order to prevent reactor vessel failure. The operators are not required to either notify or request permission from the Emergency Controller for this intentional release. This is not comprehensively discussed in the basis document.
- Step 17.2 in SOI-8.8 instructs the operators to depressurise the steam generators to 0 bar. The bases document does not discuss the negative consequences of losing flow from the turbine driven auxiliary feedwater pumps or the turbine driven charging pumps.
- Step 2.2 in SOI-8.8 directs the operators to go to step 18.0 if the core exit temperature is above 650 ºC with one or more reactor coolant pumps in service. The operators can subsequently get stuck in a procedural loop if reflooding and cooling of the core are unsuccessful.
- Step 2.2 and Step 16.6 in SOI-8.8 direct the operators to step 18.0 if the core exit temperature is above 650 ºC with one or more reactor coolant pumps in service. This criterion is however not repeated in Step 2.8 where idle reactor coolant pumps are restarted, and no explanation is given in the bases document for this apparent discrepancy.
- Steps 7.1, 9.1, 11.1, 14.1 and 19.1 in SOI-8.8 instruct the operators to check reactor vessel level if the core exit temperature is not decreasing. The Reactor Vessel Level Indication System (RVLIS) system may however become unreliable during a severe accident if molten corium relocates to the bottom vessel head and blocks the lower pressure tap-off of the RVLIS system. This is not highlighted in the bases document.
- Success Path 6 in SOI-8.8 directs the operators to inject water from the fire protection system into containment and consult the TSC to determine how much water to inject. There is however no guidance available in the bases document to assist in making this determination, or whether seawater injection should be considered.
- The bases document for SOI-8.8 does not discuss the differences between the station's severe accident approach and the generic PWR severe accident management guidance. This could create confusion if technical support is received from international organizations during a severe accident. For example, the large size of the station's containment building means that steam inerting is not required as a hydrogen management strategy whereas this is an important part of generic severe accident management approaches.

Without a comprehensive link between the severe accident procedure bases document and its underlying technical basis, technical support to the main control room and emergency organization may not be optimal.

**Suggestion:** The station should consider enhancing the bases document for the severe accident procedure to comprehensively discuss and link the severe accident management actions to its technical basis.

**IAEA Bases:**

NS-G-2.15
2.30 The guidance in both the preventive and mitigatory domains should be supported by appropriate background documentation. This documentation should describe and explain the rationale of the various parts of the guidance, and should include an explanation of each individual step in the guidance, if considered necessary. The background documentation does not replace the guidance itself.

3.57 Adequate background material should be prepared in parallel with the development and writing of guidelines. The background material should fulfil the following roles:

- It should be a self-contained source of reference for:
  - The technical basis for strategies and deviations from generic strategies, if any;
  - A detailed description of instrumentation needs;
  - Results of supporting analysis;
  - The basis for and detailed description of steps in procedures and guidelines;
  - The basis for calculations of set points;
- It should provide basic material for training courses for technical support staff and operators.

## 10.4. DEVELOPMENT OF PROCEDURES AND GUIDELINES

**10.4(1) Issue:** The severe accident management procedures do not specifically address all station operating states or provide guidance for the prioritisation of fuel storage pond accidents.

The team observed the following:

- There is no procedural link into the severe accident procedure in shutdown station states should core uncovery occur. There are no alternative entry criteria into the severe accident procedure for station states where the core exit temperature is unavailable.
- There is no specific instruction for either the Control Room (for example in SOI-8.8 Appendix S) or the TSC to monitor the fuel storage pond level during a severe accident.
- Procedure SOI-5.13.4 for abnormal conditions in the fuel storage pond instructs the operators to exit the procedure if a reactor trip occurs. There is no specific guidance to determine the urgency or prioritise actions to mitigate challenges to the fuel storage pond that are coincident with a severe accident in the reactor.

Without specifically addressing all station operating states and fuel storage pond challenges in station procedures for severe accident conditions, procedure usage may not be optimal in mitigating these challenges.

**Suggestion:** The station should consider enhancing its severe accident management - procedures to specifically address all station operating states and fuel storage pond challenges.

**IAEA Bases:**

NS-G-2.15
2.12 In view of the uncertainties involved in severe accidents, severe accident management guidance should be developed for all physically identifiable challenge mechanisms for which the development of severe accident management guidance is feasible; severe accident management guidance should be developed irrespective of predicted frequencies of occurrence of the challenge.

2.16 Severe accidents may also occur when the plant is in the shutdown state. In the severe accident management guidance, consideration should be given to any specific challenges posed by shutdown plant configurations and large scale maintenance, such as an open containment equipment hatch. The potential for damage of spent fuel both in the reactor vessel and in the spent fuel pool or in storage should also be considered in the accident management guidance. As large scale maintenance is frequently carried out during planned shutdown states, the first concern of accident management guidance should be the safety of the workforce.

# DEFINITIONS

DEFINITIONS – OSART MISSION

**Recommendation**

A recommendation is advice on what improvements in operational safety should be made in that activity or programme that has been evaluated. It is based on IAEA Safety Standards or proven, good international practices and addresses the root causes rather than the symptoms of the identified concern. It very often illustrates a proven method of striving for excellence, which reaches beyond minimum requirements. Recommendations are specific, realistic and designed to result in tangible improvements. Absence of recommendations can be interpreted as performance corresponding with proven international practices.

**Suggestion**

A suggestion is either an additional proposal in conjunction with a recommendation or may stand on its own following a discussion of the pertinent background. It may indirectly contribute to improvements in operational safety but is primarily intended to make a good performance more effective, to indicate useful expansions to existing programmes and to point out possible superior alternatives to ongoing work. In general, it is designed to stimulate the plant management and supporting staff to continue to consider ways and means for enhancing performance.

*Note: if an item is not well based enough to meet the criteria of a 'suggestion', but the expert or the team feels that mentioning it is still desirable, the given topic may be described in the text of the report using the phrase 'encouragement' (e.g. The team encouraged the plant to…).*

**Good practice**

A good practice is an outstanding and proven performance, programme, activity or equipment in use that contributes directly or indirectly to operational safety and sustained good performance. A good practice is markedly superior to that observed elsewhere, not just the fulfilment of current requirements or expectations. It should be superior enough and have broad application to be brought to the attention of other nuclear power plants and be worthy of their consideration in the general drive for excellence. A good practice has the following characteristics:

- novel;
- has a proven benefit;
- replicable (it can be used at other plants);
- does not contradict an issue.

The attributes of a given 'good practice' (e.g. whether it is well implemented, or cost effective, or creative, or it has good results) should be explicitly stated in the description of the 'good practice'.

*Note: An item may not meet all the criteria of a 'good practice', but still be worthy to take note of. In this case it may be referred as a 'good performance', and may be documented in the text of the report. A good performance is a superior objective that has been achieved or a good technique or programme that contributes directly or indirectly to operational safety and* *sustained good performance, that works well at the plant. However, it might not be necessary to recommend its adoption by other nuclear power plants, because of financial considerations, differences in design or other reasons.*

## LIST OF IAEA REFERENCES (BASIS)

***Safety Standards***

- **SF-1**; Fundamental Safety Principles (Safety Fundamentals)
- **GSR Part 3;** Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards
- **SSR-2/1**; Safety of Nuclear Power Plants: Design (Specific Safety Requirements)
- **SSR-2/2**; Safety of Nuclear Power Plants: Commissioning and Operation (Specific Safety Requirements)
- **NS-G-1.1**; Software for Computer Based Systems Important to Safety in Nuclear Power Plants (Safety Guide)
- **NS-G-2.1**; Fire Safety in the Operation of Nuclear Power Plans (Safety Guide)
- **NS-G-2.2**; Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants (Safety Guide)
- **NS-G-2.3**; Modifications to Nuclear Power Plants (Safety Guide)
- **NS-G-2.4**; The Operating Organization for Nuclear Power Plants (Safety Guide)
- **NS-G-2.5**; Core Management and Fuel Handling for Nuclear Power Plants (Safety Guide)
- **NS-G-2.6**; Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants (Safety Guide)
- **NS-G-2.7**; Radiation Protection and Radioactive Waste Management in the Operation of Nuclear Power Plants (Safety Guide)
- **NS-G-2.8**; Recruitment, Qualification and Training of Personnel for Nuclear Power Plants (Safety Guide)
- **NS-G-2.9**; Commissioning for Nuclear Power Plants (Safety Guide)
- **NS-G-2.11**; A System for the Feedback of Experience from Events in Nuclear Installations (Safety Guide)
- **NS-G-2.12**; Ageing Management for Nuclear Power Plants (Safety Guide)
- **NS-G-2.13**; Evaluation of Seismic Safety for Existing Nuclear Installations (Safety Guide)
- **NS-G-2.14**; Conduct of Operations at Nuclear Power Plants (Safety Guide)
- **NS-G-2.15**; Severe Accident Management Programmes for Nuclear Power Plants (Safety Guide)

- **SSG-13**; Chemistry Programme for Water Cooled Nuclear Power Plants (Specific Safety Guide)
- **SSG-25**; Periodic Safety Review for Nuclear Power Plants (Specific Safety Guide)
- **GSR Part 1**; Governmental, Legal and Regulatory Framework for Safety (General Safety Requirements)
- **GS-R-2**; Preparedness and Response for a Nuclear or Radiological Emergency (Safety Requirements)
- **GS-R-3**; The Management System for Facilities and Activities (Safety Requirements)
- **GSR Part 4**; Safety Assessment for Facilities and Activities (General Safety Requirements)
- **GS-G-4.1**; Format and Content of the Safety Analysis report for Nuclear Power Plants (Safety Guide)
- **SSG-2**; Deterministic Safety Analysis for Nuclear Power Plants (Specific Safety Guide)
- **SSG-3**; Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants (Specific Safety Guide)
- **SSG-4**; Development and Application of Level 2 Probabilistic Safety Assessment for Nuclear Power Plants (Specific Safety Guide)
- **GSR Part 5**; Predisposal Management of Radioactive Waste (General Safety Requirements)
- **GS-G-2.1**; Arrangement for Preparedness for a Nuclear or Radiological Emergency (Safety Guide)
- **GSG-2**; Criteria for Use in Preparedness and Response for a Nuclear and Radiological Emergency (General Safety Guide)
- **GS-G-3.1**; Application of the Management System for Facilities and Activities (Safety Guide)
- **GS-G-3.5**; The Management System for Nuclear Installations (Safety Guide)
- **RS-G-1.1**; Occupational Radiation Protection (Safety Guide)
- **RS-G-1.2**; Assessment of Occupational Exposure Due to Intakes of Radio-nuclides (Safety Guide)
- **RS-G-1.3**; Assessment of Occupational Exposure Due to External Sources of Radiation (Safety Guide)
- **RS-G-1.8**; Environmental and Source Monitoring for Purposes of Radiation Protection (Safety Guide)

- **SSR-5;** Disposal of Radioactive Waste (Specific Safety Requirements)
- **GSG-1** Classification of Radioactive Waste (General Safety Guide)
- **WS-G-6.1**; Storage of Radioactive Waste (Safety Guide)
- **WS-G-2.5**; Predisposal Management of Low and Intermediate Level Radioactive Waste (Safety Guide)

▪ ***INSAG, Safety Report Series***

- **INSAG-4**; Safety Culture
- **INSAG-10**; Defence in Depth in Nuclear Safety
- **INSAG-12**; Basic Safety Principles for Nuclear Power Plants, 75-INSAG-3 Rev.1
- **INSAG-13**; Management of Operational Safety in Nuclear Power Plants
- **INSAG-14**; Safe Management of the Operating Lifetimes of Nuclear Power Plants
- **INSAG-15**; Key Practical Issues In Strengthening Safety Culture
- **INSAG-16**; Maintaining Knowledge, Training and Infrastructure for Research and Development in Nuclear Safety
- **INSAG-17**; Independence in Regulatory Decision Making
- **INSAG-18**; Managing Change in the Nuclear Industry: The Effects on Safety
- **INSAG-19**; Maintaining the Design Integrity of Nuclear Installations throughout their Operating Life
- **INSAG-20**; Stakeholder Involvement in Nuclear Issues
- **INSAG-23**; Improving the International System for Operating Experience Feedback
- **INSAG-25**; A Framework for an Integrated Risk Informed Decision Making Process
- **Safety Report Series No.11**; Developing Safety Culture in Nuclear Activities Practical Suggestions to Assist Progress
- **Safety Report Series No.21**; Optimization of Radiation Protection in the Control of Occupational Exposure
- **Safety Report Series No.48**; Development and Review of Plant Specific Emergency Operating Procedures
- **Safety Report Series No. 57**; Safe Long Term Operation of Nuclear Power Plants

- ***Other IAEA Publications***

  - **IAEA Safety Glossary** Terminology used in nuclear safety and radiation protection 2007 Edition
  - **Services series No.12**; OSART Guidelines
  - **EPR-EXERCISE-2005**; Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency
  - **EPR-METHOD-2003**; Method for developing arrangements for response to a nuclear or radiological emergency, (Updating IAEA-TECDOC-953)
  - **EPR-ENATOM-2002**; Emergency Notification and Assistance Technical Operations Manual

- ***International Labour Office publications on industrial safety***

  - **ILO-OSH 2001;** Guidelines on occupational safety and health management systems (ILO guideline)
  - Safety and health in construction (ILO code of practice)
  - Safety in the use of chemicals at work (ILO code of practice)

## TEAM COMPOSITION OF THE OSART MISSION

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IAEA
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**RANGUELOVA Vesselina**
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**DUTTO Jean-Baptiste**
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Review Area: Leadership and management for safety

**DIETZE Sharon**
Bruce B NPP
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Review Area: Training and qualification

**ZINCHENKO Anatoly**
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Review Area: Operations 1

**OGANDO Alexandre**
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Years of nuclear experience: 45
Review Area: Technical support

**MURRAY Pat**
Peak Performance Through Innovative Solutions
Years of nuclear experience: 32
Review Area: Operating experience

**JEANNIN Bernard**
IAEA
Years of nuclear experience: 32
Review Area: Radiation protection

**JURGENSEN Micael**
EnBW Kernkraft GmbH – Kernkraftwerk Philippsburg
Years of nuclear experience: 27
Review Area: Chemistry

**LEMAY Francois**
International Safety Research
Years of nuclear experience: 32
Review Area: Emergency preparedness and response

**BOSMAN Herman**
ESKOM
Years of nuclear experience: 12
Review Area: Severe accident management

**YAMAJI Norisuke**
IAEA
Years of nuclear experience: 17
Review Area: Observer 1

**SOBRAL DA COSTA Daniel**
Eletrobras Eletronuclear Angra 1 and 2 NPP
Years of nuclear experience: 7
Review Area: Observer 2