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REPORT

OF THE

OPERATIONAL SAFETY REVIEW TEAM (OSART)

MISSION

TO THE

Units 6 and 7 of Kashiwazaki-Kariwa

NUCLEAR POWER PLANT

Japan

29 June – 13 July 2015

DIVISION OF NUCLEAR INSTALLATION SAFETY
OPERATIONAL SAFETY REVIEW MISSION
IAEA-NSNI/OSART/183/2015

PREAMBLE

This report presents the results of the IAEA Operational Safety Review Team (OSART) review of Units 6 and 7 of the Kashiwazaki-Kariwa Nuclear Power Station, Japan. It includes recommendations for improvements affecting operational safety for consideration by the responsible Japanese 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 Japanese organizations is solely their responsibility.

FOREWORD

Director General

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

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

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 methodology involves 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.

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INTRODUCTION AND MAIN CONCLUSIONS

INTRODUCTION

At the request of the government of Japan, an IAEA Operational Safety Review Team (OSART) of international experts visited units 6 and 7 of the Kashiwazaki-Kariwa Nuclear Power Station from 29 June to 13 July 2015. The purpose of the mission was to review operating practices in the areas of Leadership and Management for Safety, Training and Qualification; Operations; Maintenance; Technical Support; Operating Experience; Radiation Protection including Post Accident Sampling; Emergency Planning and Preparedness and Severe Accident Management. In addition, an exchange of technical experience and knowledge took place between the experts and their plant counterparts on how the common goal of excellence in operational safety could be further pursued.

Kashiwazaki-Kariwa nuclear power station is located almost at the centre of Niigata Prefecture between Kashiwazaki City and Kariwa Village on the coast of the Sea of Japan. The site covers an area of around 4.2 million square metres and is encircled by a hilly area of pine forest. Kashiwazaki city, to the south, has a population of approximately 92000 and Kariwa village, to the east, approximately 5000.

There are seven units on the site; all operated by the Tokyo Electric Power Company (Tepco), Units 1 to 5 are 1100 MWe BWR5 Reactors. Unit 1 has a Mark II containment vessel, units 2 to 5 have Mark II advanced containment vessels. Units 6 and 7 are 1356 MWe Advanced BWRs in ABWR containments. Units 1 to 5 were commissioned between 1985 and 1990, Unit 6 entered commercial operation in 1996 and Unit 7 in 1997. In total the site has an installed capacity of 8212 MWe, delivered to the grid system via two 500kV power lines with the possibility of upgrading one of these lines to 1000kV in the future. There are approximately 1100 Tepco personnel on the site and 4500 contractor personnel.

All seven units at the station have been shut down since March 2012. In the period since then the station has been implementing a significant programme of enhancements to the site, the installed plant and management programmes and procedures to enhance the robustness of defences against severe accidents.

The 2015 Kashiwazaki-Kariwa OSART mission was the 183rd in the programme, which began in 1982. The team was composed of experts from Canada, the Czech Republic, Finland, France, Slovakia, Sweden, the United Kingdom and the United States and the collective nuclear power experience of the team was approximately 350 years.

Before the OSART mission, the team studied information provided by the IAEA and the Kashiwazaki-Kariwa station to familiarize themselves with the main features and performance of the station, 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 plant performance, witnessed work in progress, the behaviours of workers and management, and held in-depth discussions with workers at the station. In addition the team observed the work done to address issues arising from the 2011 events at Fukushima-Daiichi

Throughout the review, the exchange of information between the OSART experts and Kashiwazaki-Kariwa 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 are based on the station's performance and programmes compared with the IAEA's 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 Kashiwazaki-Kariwa power station are committed to improving the operational safety and reliability of their station. The team found good areas of performance, including the following:

- Following the March 2011 accident at Fukushima Daiichi, Kashiwazaki-Kariwa has implemented comprehensive and robust defences against severe accidents, including additional tsunami and internal flood protection measures as well as enhanced installed and mobile back-up electrical power supplies, pumps and heat exchangers;
- The station carries out frequent drills in challenging scenarios to ensure the station personnel are well-prepared to deal with emergencies even under difficult environmental conditions;
- The station has established thorough control of all combustible materials and ignition sources to minimize fire risk.

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

- Systems to gather operating experience in the different management areas in the station should be integrated and the information collected should be used more proactively to detect and correct low level issues before they become significant, and enable the station to better exchange 'lessons-learned' with the rest of the nuclear industry;
- The existing severe accident management guidance should be enhanced to cover all plant conditions including potential events involving the spent fuel pools;
- The station's emergency plans covering all situations should be more fully integrated and documented in a way that is clear and easy to use.

Kashiwazaki-Kariwa station 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 ORGANISATION AND ADMINISTRATION DEVELOPMENT

The station has a robust set of management documents which clearly specify the responsibility for safety, senior managers' responsibilities and accountability including interactions with the corporate organisation.

The Nuclear Power Division Management Guidelines document clearly defines policies of the station and in section 6 also defines 23 'Ideal State of process' each having its own improvement plan. The Station is encouraged to continue the focus on these improvement plans ensuring there are clear 'Who, What and When' criteria.

1.2 STRUCTURES AND FUNCTION OF THE OPERATING ORGANISATION

The station has an industrial safety programme including leadership coaching in the field.

However some industrial safety rules, procedures and instructions are not always commensurate with the risk and adherence in the field is not always consistent.

During field observations, workers displayed inconsistent use of personnel protective equipment and inconsistent understanding of station industrial safety rules.

Low level behaviour events and near misses are not systematically recorded and so cannot be trended. The team made a recommendation in this area.

During the mission, the team observed behaviours of station staff in comparison with the safety culture attributes promoted in the IAEA Safety Standards. The team identified a number of facts related to strengths and weaknesses that could assist management efforts regarding safety culture at Kashiwazaki Kariwa.

With respect to the strengths, the team recognized the following:

- The station staff were highly cooperative and reacted very positively when the team discussed possible improvements;
- Station material conditions and housekeeping are very good despite very intensive on-going reconstruction and safety enhancement work;
- The station staff use systematic self-checking tools during all work activities.

However, some other features indicate that additional efforts could result in further improvement of safety culture. For example:

- Industrial safety concerns are present in the field but are not consistently being recorded or addressed;
- Management expectations in the area of industrial safety are not always adhered to, especially by contractors.

Leadership in the field and low level reporting and trending need improvement so that declining performance is detected and corrected before becoming more significant.

1.2 STRUCTURE AND FUNCTION OF THE OPERATING ORGANISATION.

1.2(1) Issue: Some industrial safety rules, procedures and instructions are not always commensurate with the risk and adherence in the field is not always consistent; measurement and trending of industrial safety behaviours in the field is not fully effective.
During the plant tour the team observed the following:

- On one occasion workers working at height were wearing harnesses but were not immediately clipped on;
- On another occasion a worker was wearing a harness and performing work involving a risk of slipping/falling (cement mixer chute) but was not secured;
- Several workers in the field carrying out manual work were not wearing protective gloves;
- Some members of station staff wore cotton gloves, some did not and when questioned gave inconsistent explanation of the rules;
- Staff observed not adhering to the 'hold the hand rail' policy;
- Worker observed using a heavy hammer with another worker in the vicinity.

The team also noted that low-level behavioral events and near misses are not systematically recorded and so cannot be trended.

Without clearly understood industrial safety standards and expectations, commensurate with the risks and their reinforcement in the field, the risk of an industrial safety event will increase.

Recommendation: The plant should ensure industrial safety policy standards, commensurate with the risks, are clearly communicated and understood and then enforced by leadership in the field. Near misses and low level events should be reported, recorded and trended

IAEA Basis:

Requirement 23

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

2. TRAINING AND QUALIFICATIONS

2.2 QUALIFICATION AND TRAINING OF PERSONNEL

The station line departments' managers and leaders are involved in the training process for their subordinates. A good understanding of ownership of training programs and materials was demonstrated by operations and maintenance group managers during interviews.

Regular meetings about Training for station line departments are conducted. Training needs for line personnel and other relevant training topics are discussed during these meetings. There is a regular monthly meeting of Operations Group Managers with all available Shift Supervisors, which also covers communication regarding training policy and training goals. There is an expectation for line managers to regularly observe training activities for their personnel. However, this expectation is not fully followed as expected. The team encourage the station to continue and enhance training observations.

NI-20-guide 3 'Education and Training Programme Development and Evaluation Guideline for Technical Staff Members in Nuclear Power Department', is a document that describes the use of the Systematic Approach to training (SAT) methodology. SAT is used as standard for operations personnel. Expected outputs from SAT phases, such as task lists, Difficulty-Importance-Frequency (DIF) analyses, learning objectives, training materials, examination tests, etc. are available.

Well-structured initial and continuing training programmes are in place for operational personnel and initial training programmes for maintenance and other technical staff. There is detailed and comprehensive planning of operational personnel continuing training broken down to individual level. It contains all expected topics such as operating experience, station performance issues, station modifications, procedure modifications. In the event of station modifications the training for operation staff contains the purpose, construction, operational rules, interlocks, and other details for modified equipment. However, continuing training programmes for maintenance and other technical staff are not formally established and the team suggested an improvement in this area.

The team observed a well-conducted simulator evaluation session of main control room operators at the site simulator. After the session, a detailed post-briefing was held, good feed-back was provided to the operator and an open and interactive discussion was held between evaluator and operator. Based on results of a yearly evaluation, trainees who achieve lower level results receive specific training on the relevant topics; and are then evaluated again. This approach maintains the knowledge and skills level of operational staff. However, the team suggested the station consider the development and implementation of pass/fail criteria for this evaluation.

Team coordination training, known as Family simulator training, is provided to the whole of each shift crew. Additional individual simulator training is provided to shift crew members. This covers normal, abnormal, emergency and severe accident scenarios. Since 2015, the total number of simulator training days has been increased by 50% in order to maintain team skills and good communication within the team. Good use of supervisory techniques, communication skills, including three-way communication and self-checking tools during a simulator training session on emergency operating procedures were observed by the team.

Site-specific induction training is provided to all contractors before issuing the site entrance badge. Additional general safety, nuclear safety, radiation protection and site-specific classroom training is conducted for contractors' team leaders and plant personnel.

However, according to the currently implemented training schedule, some contractor's team leaders do not have the opportunity to receive any station representative expectations during the whole period of training. The on-the-job-training (OJT), which includes training of station personnel in coaching, is used during initial training for newly hired personnel as well as for further enhancement of personnel skills. The OJT instructors receive classroom training for trainers; however they are not given the opportunity to practice the lecturer's skills during these lessons. In some cases, it is pure text-book training. The team observed several classroom training events and recommended an improvement in this area.

The radiation protection classroom at the contractor's training facility is well equipped with various clothing, shoes, masks, gloves and other personal protective equipment typically used in the Radiation Controlled Area (RCA). The station has a very well equipped maintenance training facility with a large number of models, mock-ups, Instrumentation & Control and Electrical workshops, visual posters and well equipped classrooms. The station site simulator is capable of simulating normal, abnormal, emergency and severe accident conditions up to 3000^{o}C fuel temperature. These training facilities provide an excellent opportunity for hands-on training of station personnel. The team observed several training sessions in these facilities and recognised this as a good performance.

Classroom training on emergency response is provided to all station personnel during induction training. An e-learning module on accident management is also provided to all station personnel. Emergency drills of the emergency response organisation (ERO) are conducted on a monthly basis. The station has made a significant commitment to using training to improve performance and ensure a high state of readiness in response to design extension conditions. The team identify this as a good practice.

There is a formally established programme to maintain and update instructor's technical skills by conducting field walk-downs and observations. However, due to the prolonged station shut-down the instructors currently do not see added value in conducting such field tours, and neither field tours nor walk-downs are conducted by instructors. The team encourages the station to continue with this program for instructors.

DETAILED TRAINING AND QUALIFICATION FINDINGS

2.2 QUALIFICATION AND TRAINING OF PERSONNEL

2.2(a) Good Practice: The station has made a significant commitment to using training to improve performance and ensure a high state of readiness in response to design extension conditions.

- The simulator used for U6/U7 training has been modified to model severe accident conditions. This enhances operator and ERO training;
- Operators and selected ERO personnel receive specific training on how to deal with the physical and mental stress that could occur during an extended large scale event such as experienced at Fukushima Daiichi. This includes understanding how the body reacts to stress and specific actions that can be taken to manage the stress. To enhance this training, role plays are conducted in which stress is introduced, heart rate and blood flow are monitored to show personnel how the body responds;
- Training for restoration team members on the use of portable equipment includes working in harsh environmental conditions and this is practiced in the field:
    - Radiation – wearing full face respirators, tungsten impregnated body shielding, and protective clothing and rubber gloves/boots;
    - Low light levels / night – practicing in the dark using portable lights;
    - Bad weather – practicing using rain suits, cold weather gear;
- Practical drills are arranged weekly and about 70 persons from TEPCO’s Radiation Safety Department participate. The drills include emergency sampling, management of Alarming Pocket Dosimeters (APDs) during an emergency, set up of the movable radiation monitoring stations, contamination control for the Technical Support Centre and Main Control Room (MCR) during the emergencies and movable Whole Body (WB)-counting devices, among others;
- To supplement maintenance personnel qualified to operate emergency equipment, the station has requested 100 employees to become licensed to operate heavy machinery and be trained for debris removal following an emergency coincident with a natural disaster. The goal is to minimize the vulnerability of this key emergency capability to personnel losses and still maintain an effective capability to deploy and operate critical emergency equipment. This is a good example of the cross-functional training implemented by the station to improve its resilience to disasters.

2.2 (1) Issue: Current training methods do not ensure that classroom training is effective.

The team observed several classroom training sessions during the review: legally required contractors` team leader training, nuclear and station site-specific contractors` team leader training and Radiation Protection training.

The team observed the following facts:

- There was limited or no interaction between the instructor and the trainees during the observed training sessions;
- During the legally required classroom training:
  - no didactic tools were used (no pictures, photos, videos etc);
  - the lesson was limited to the instructor reading from the textbook with only a few examples oral or additional information provided;
  - Several participants were completely inattentive about 15 minutes after the start of the lesson.

Not using appropriate classroom training methods can lower the attention of trainees and, as a result, decrease the effectiveness of the training session and the ability of qualified workers to perform safety related activities.

Recommendation: The station should implement appropriate training methods for classroom training in order to ensure the effectiveness of classroom sessions.

IAEA Basis:

SSR -2/2

4.23. All training positions shall be held by adequately qualified and experienced persons, who provide the requisite technical knowledge and skills and have credibility with the trainees. Instructors shall be technically competent in their assigned areas of responsibility, shall have the necessary instructional skills and shall also be familiar with routines and work practices at the workplace. Qualification requirements shall be established for the training instructors.

NS-G-2.8

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

2.2(2) Issue: Pass/fail criteria have not been established or used to evaluate periodic training performance of MCR operators

Although yearly knowledge evaluations are conducted of all operational personnel as well as simulator evaluations of MCR personnel, the team observed the following facts:

- Although MCR personnel are graded no pass/fail criteria are set for periodical evaluation sessions of operators;
- BWR Training Facility (BTC: the independent education and training organization for the station), has pass/fail criteria set for initial authorisation of operators;
- BTC has criteria for the periodic simulator evaluation sessions; however these criteria are used only to specify retraining for operators;
- The station site simulator has criteria for periodical evaluation sessions. The criteria and the results of the evaluation are used for individual`s retraining specification;
- There are criteria set for knowledge evaluations for operator positions. Retraining is specified for each operator based on individual evaluation results.

Without pass/fail criteria established or the rigorous and effective use of pass/fail criteria, the station may not take the appropriate actions to manage individuals with unacceptable performance.

Suggestion: The station should consider developing and implementation of pass/failure criteria for periodic evaluations of MCR operations personnel.

IAEA Basis:

NS-G-2.8

3.1 Competence may be developed through education, experience and formal training. For specific safety related functions, several competence criteria may need to be satisfied, …

3.7 The competence of each individual should be assessed against established requirements before that individual is assigned to a position. The competence of all individuals should be fully assessed periodically by various means while they perform the duties allocated to their position; the assessment should also cover the actual individual performance in the workplace. The requirements should be established in such a way as to ensure that the competences are appropriate to the tasks and activities to be performed.

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

7.10 In the assessment of an individual's competence as a basis for an authorization, documented and approved criteria should be used. These criteria should include, but are not limited to, the following areas:

- Knowledge of the established safety rules and regulations as appropriate for the job;
- Technical, social, administrative and management knowledge and skills as appropriate for the job;
- Required education, training and experience;
- Measurements of job performance.

In addition, medical fitness for duty should be required.

2.2(3) Issue: There are no formally established continuing training programmes for maintenance and other technical personnel such as radiation protection, chemistry and fuel management based on the systematic approach to training.

The team observed the following facts:

- A formal continuing training programme for maintenance, radiation protection, chemistry and fuel management has not been developed at the station;
- Some training is provided to the above mentioned personnel regarding process or procedure changes or newly installed equipment. However, this training is managed by station line departments, training departments are not involved;
- It is considered an individual station personnel responsibility to ask for continuing training in these departments;
- A simplified implementation of SAT methodology is used for development of training programmes for maintenance and other technical personnel.

Without a continuing training programme for personnel whose functions are important to safety, the station cannot be assured that levels of qualification and competence of plant personnel are adequately maintained and upgraded when necessary.

Suggestion: The station should consider establishing a formal continuing training programme for maintenance and other technical personnel such as radiation protection, chemistry and fuel management based on the systematic approach to training.

IAEA Basis:

NS-G-2.8

4.29 Continuing training should be carried out on a regular basis. A programme should be conducted periodically for all groups of personnel whose functions are important to the safe operation of the plant. By means of continuing training based on a systematic approach, it should be ensured that levels of qualification and competence are maintained and upgraded when necessary…

4.31 The time necessary for all personnel to undergo formal continuing training on a regular basis should be taken into account when work schedules are established. In the case of the maintenance group, refresher training should be given on maintenance activities that are normally performed only infrequently.

3. OPERATIONS

3.1 ORGANISATION AND FUNCTIONS

Any experienced operator who is rotated between any of the seven units, or any operator who is rotated back to Main Control Room (MCR) duties, undertakes a special retraining course which covers the features and activities specific to the unit. The training period is determined and prescribed based on the individual's previous Operations shift position and his/her new position. The training plan is developed by the manager of the trainee, based on the trainee's abilities and previous experience. This was evaluated as a Good Practice by the team.

There are gaps in the documented processes and procedures within the Operations Department. The team observed that there is no specific job description below the level of Shift Supervisor (SS) which states the authorities and responsibilities of these Operations staff; there is no fitness-for-duty programme for operators and there are various operator aids which are not controlled. The team made a recommendation in this area.

3.4 CONDUCT OF OPERATIONS

Several MCR operators are selected by the SS at the start of each shift to take turns to continuously monitor the station status. Previously, operators had a tendency to monitor as a team and on occasion depended on someone else in the team, for example when monitoring was disrupted due to telephone calls, visitors etc. The monitor wears a red armband to distinguish them from other operators. The monitor's work station is pre-designated and all the necessary instruments, controllers, indicators and screen monitors are visible from this position. This is considered as a Good Performance by the team.

A comprehensive surveillance test programme exists. Acceptance criteria are set out in the individual tests and the operators confirm that the test results are within the acceptance criteria. The test results are correctly recorded on the test sheet and entered into a spreadsheet. The System Engineers Group has commenced trending of these results on 5 systems and the number will be increased to 40 systems by March 2016. The station is encouraged to continue with this initiative and to maintain close contact between the System Engineers Group and the Operations Department.

3.5 WORK CONTROL

The Work Control Guide states that the maximum period between Work Package production and implementation of the Clearance Package is 15 weeks. This is not being fully adhered to during the current extended outage as some of these packages are in excess of 15 weeks. The station is encouraged to bring all documented practices into line with their controlling documents.

3.6 FIRE PROTECTION AND PROTECTION PROGRAMME

There is a comprehensive, well documented programme established and implemented to perform appropriate inspection, maintenance and testing of all fire protection equipment and systems and for assuring that fire barriers are properly maintained. A substantial fire protection improvement programme is in place to improve fire resistance of fire barriers (including walls, doors, penetrations, fire dampers and cable wrapping) from two hours to three hours. In addition, more than 100 automatic fire suppression systems are installed in rooms with safety or safety related equipment using new smoke and heat detectors (some already installed, some under installation), there are about 250 fire watch cameras installed per unit with monitors in the MCR and the fire brigade building and about 300 LED emergency lights per unit. The team recognized these activities as a good performance.

Strict control of combustible material and ignition sources is part of the fire protection strategy. It is also part of the work authorization process. The team recognized this as a good practice

There is a fire brigade on the site at all times consisting of 6 professional fire fighters as well as an on-shift fire brigade which consists of a minimum of three trained fire fighters. In addition, there is a Memorandum of Understanding between the station and the Kashiwazaki city fire brigade describing the conditions for training and drills, fire alarm reporting and fire fighting. Some arrangements for professional fire brigades could adversely affect their response and the team made a suggestion for further enhancement.

The adequacy of the station’s current fire protection systems is verified by an updated Fire Hazard Analysis (FHA), developed through the periodic safety review (PSR). This analysis demonstrates the assurance of safe reactor shutdown and cooling in the event fire. Development of the fire Probabilistic Safety Assessment has commenced and will be completed in 2016.

DETAILED OPERATIONS FINDINGS

3.1 ORGANISATION AND FUNCTIONS

3.1(a) Good Practice: Structured requalification training period.

Any experienced operator who is rotated between any of the seven units, or any experienced operator who is rotated back to the MCR undertakes a special retraining course which covers the following:

- Unique features of the unit;
- Modifications that have been performed;
- Differences in technical specifications and documents;
- Current work in progress.

The training period is determined and prescribed based on the individual’s previous Operations shift position and his/her new position. The training plan is developed by the manager of the trainee, based on the trainee’s abilities and previous experience.

The trainee’s manager is responsible for ensuring the trainee`s understanding of the differences between the previous and newly assigned position.

3.1(1) Issue: There are gaps in the documented processes and procedures within the Operations Department.

The team observed the following:

- There is no specific job description below the level of Shift Supervisor (SS) which states the authorities and responsibilities of these Operations staff;
- There is no fitness-for-duty programme for operators;
- Unit 7 'Containment Atmospheric Monitoring System' panel H11-P638-1 has an illuminated alarm window indicating that it is in the alarm condition but there is no associated alarm response procedure for the operators to act upon.
- A designated shift is responsible for the control of operator aids but several examples indicate that control could be improved, for example:
  - o Unit 6 Control Rod Manipulation Monitoring Control Panel H11-P615-1 has a Revision 2 MCR subpanel layout diagram on the panel but the latest Revision is 6.
  - o Unit 7 Safety Protection system panel H11-P661-4 has a MCR subpanel layout diagram attached which has no unique reference or date
  - o Unit 7 Process radiation monitor panel H11-P604-3 has a folder containing drawings. The folder cover has an approved tag on it but there is no such approval for each of the contents and these contain handwritten information.

Without adequate control of all operational activities, the safe operation of the station could be compromised.

Recommendation: The Operations Department should identify and address all gaps in the documents governing the conduct of operations.

IAEA Basis:

SSR-2/2

3.13. A staff health policy shall be instituted and maintained by the operating organization to ensure the fitness for duty of personnel. Attention shall be paid to minimizing conditions causing stress, and to setting restrictions on overtime and requirements for rest breaks. The health policy shall cover the prohibition of alcohol consumption and drug abuse.

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.

NS-G-2.14

2.21. The operations management should support shift operations by ensuring that all necessary requirements for each shift position, such as qualification, job descriptions, training and licenses, are sufficient to establish and maintain comfortable working conditions for each shift…

4.25. Alarm response procedures should be established for all alarm panels.

These procedures should guide operators in verifying abnormal conditions or changes in plant status and should specify the appropriate subsequent action or procedures. Alarm response procedures should be available at the affected alarm panels and should be easily accessible to the operators who are responding to alarms.

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.

3.6(a) Good practice: Management of transient combustible materials

The station has developed and implemented strong systematic management and control of combustible materials.

(1) The primary contractor submits an application to the Maintenance Management Group. At that time, the field map (indicating 'no temporary storage' areas, hot work areas and other temporary storage areas) is verified on the intranet to select a storage location. At the same time, fire load assessment of the temporary storage item is conducted.

(2) The Maintenance Management Group checks the application and verifies 'period,' 'reason', 'location', 'important equipment: Yes/No', 'if Yes, adequacy', 'items (include quantity, calorific value)', 'TEPCO group in charge', 'primary contractor', 'fire load assessment results'. The result of the fire load assessment is compiled by the Maintenance Management Group, and it verifies in advance if there are any temporarily stored items in the same area. If there are already items being stored temporarily, the total calorific value, obtained by adding together the assessment results, is used to determine if temporary storage can be permitted. A 'Request for correction' is issued if necessary. Applications with no issues are sent to the TEPCO work supervisor.

(3) The TEPCO work supervisor circulates the application to the manager(s) for verification. Once it is approved (permitted) by the shift supervisor, the application is returned to the primary contractor.

(4) The approved application is shared as information with the Maintenance Management Group, and the field map is updated.

(5) The application returned to the primary contractor is posted in the field, and items are temporarily stored.

(6) The TEPCO work supervisor and primary contractor manager checks the status of temporary storage in the field and puts the date and signature of the verifier on the posted application form.

(7) The Maintenance Management Group conducts daily patrols based on the information registered on the field map and verifies temporary storage conditions from an independent perspective. A 'Request for correction' is issued if necessary.

Note that in-field equipment and materials for operations shifts are also managed as part of the scope of these rules.

Exemptions
If temporary storage is unavoidable in a 'no temporary storage' area due to maintenance activities, an exemption application is submitted in advance to the fire protection management for approval. The approved exemption application and temporary storage application are submitted together to the Maintenance Management Group.

For exemptions, additional safety measures (such as placement of temporary fire detectors and ensuring use of metal containers) are considered and implemented.

3.6(1) Issue: Station arrangements for the on-shift fire brigade composition and the on-site professional fire brigade practical retraining and escort could adversely affect their response to fire alarms.

During the review the team noted the following:

- Minimum shift composition for cold shutdown, stated in the Technical Specifications, will not ensure the requirements for minimum on-shift fire brigade composition (three fire-fighters);
- The time limit for the on-site professional fire brigade to reach a fire is 10 minutes;
- The on-site professional fire brigade is able to depart the fire brigade station within 1 minute, however, they are requested to wait at the entrance to the units for an escort;
- The response time taken during the last three exercises exceeded 10 minutes;
- The 10 minute time limit was not achieved during actual fires experienced at the station;
- There is no requirement for special fire-fighting retraining for the on-site professional fire brigade as practiced for the on-shift fire brigade.

Without proper arrangements for the availability and training of the on-shift fire brigade and the on-site professional fire brigade, their appropriate response to a fire cannot be ensured.

Suggestion: The station should consider enhancing its arrangements for the on-shift fire brigade composition, as well as the practical retraining and escort of the on-site professional fire brigade, to ensure an effective response to fire alarms.

IAEA Bases:

SSR-2/2

Req.22. The operating organization shall make arrangements for ensuring fire safety.

5.21. The arrangements for ensuring fire safety made by the operating organization shall cover the following: adequate management for fire safety… Such arrangements shall include but are not limited to:

(d) Establishment of a manual fire fighting capability;

NS-G-2.1

8.1 A fire fighting strategy should be developed for each area of the plant identified as important to safety (including those areas which present a fire exposure risk to areas important to safety). These strategies should provide information to supplement the information provided in the general plant emergency plan. The strategies should provide all appropriate information needed by fire fighters to use safe and effective fire fighting techniques in each fire area. The strategies should be kept up to date and should be used in routine classroom training and in actual fire drills at the plant. The fire fighting strategy developed for each fire area of the plant should cover the following:

—access and exit routes for fire fighters;

8.2. Plant documentation should provide a clear description of the manual fire fighting capability provided for those areas of the plant identified as important to safety. The manual fire fighting capability may be provided by a suitably trained and equipped on-site fire brigade, by a qualified off-site service or by a co-ordinated combination of the two, as appropriate for the plant and in accordance with national practice.

8.4. Where full or partial reliance for manual fire fighting capability is placed on off-site resources, there should be proper co-ordination between the plant personnel and the off-site response group in order to ensure that the latter is familiar with the hazards of the plant. The responsibilities and lines of authority for manual fire fighting personnel should be documented in a fire fighting plan.

8.5. If an on-site fire brigade is established to provide a manual fire fighting capability, the fire brigade's organization, minimum staffing level, equipment (including self-contained breathing apparatus) and training should all be documented and their adequacy should be confirmed by a competent person.

8.6. Members of the on-site fire brigade should be physically capable of performing fire fighting duties and should attend a formal programme of fire fighting training prior to assignment to the plant fire brigade. Regular training (routine classroom training, fire fighting practice and fire drills) should be provided for all on-site fire brigade members. Special training should be provided for fire brigade leaders to ensure that they are competent to assess the potential safety consequences of a fire and advise control room personnel.

4.5 MAINTENANCE AND TECHNICAL SUPPORT

4.2 STATION MODIFICATION SYSTEM (SAFETY ENHANCEMENT PROJECTS)

Station modifications are identified, specified, screened, designed, evaluated, authorized, implemented and recorded in accordance with the Design Management Basic Manual revised in 2014. Each modification is evaluated for its safety significance, and is placed into one of four safety categories. The Corporate Office is responsible for all modifications categorized as Is, which is the highest class and represents mostly new designs. The plant can initiate design modifications of a lower safety class.

However, design engineering of recent safety enhancement projects, regardless of their safety classification is performed by the corporate office. The team understood that the Corporate Office has not established the complete role and function of an overall design authority.

Contractors, supervised by plant maintenance group, carry out installation of modifications. After testing and commissioning is performed, all the design documents submitted in relation to modifications are appropriately stored in the station's 'DREAMS' system, which contains all vendor detailed documents and is accessible to station as well as corporate staff. However, the team realised that there is no guarantee that the system covers all necessary and complete information collected throughout the station lifetime. The team incorporated this into the suggestion in 4.6.

4.3. MAINTENANCE PROGRAMMES

A specific ageing management review and scoping procedure is required once a unit life reaches 30 years. The review shall identify existing and potential degradation mechanisms of Structures, Systems and Components (SSCs) and their further management in the continued operation of the station. The plant has initiated a procedure for overall ageing management review of SSCs for Unit 1 only. For Unit 6 and 7 the station has currently limited specific ageing management activities and relies on results from maintenance programme for active components and In-Service Inspection results for the passive SSCs.

The team encourages the station to implement an overall ageing management review of Units 6 and 7.

4.4 CONDUCT OF MAINTENANCE WORK

Without its own maintenance forces and capacity, the station is fully dependant on external suppliers for maintenance activities. In general the station maintenance personnel have a management and supervisory role only. External contractors carry out almost all the maintenance work.

Based on lessons learned from the Fukushima event there is an on-going training programme at the plant to train maintenance group personnel to carry out limited work as emergency maintenance. This has been observed as an important improvement of initial station practice. The team encourages the station to develop this practice and establish the station's own well qualified and equipped maintenance force in order to reduce the full reliance on contractors' capabilities for emergency corrective maintenance.

4.6 CONFIGURATION CONTROL

In the past the station used the original supplier, as the overall repository of all design specifications and changes, including reliable and long term storage and access to design basis data. However, the current situation is that design and implementation of some safety related modifications are performed by contractors other than the original supplier. In such cases, a long term storage and safekeeping of detailed contractor design data has not been clearly established. Therefore TEPCO does not have guaranteed access to all necessary design basis documentation from either the original or the new supplier. This is to be solved at corporate level as further plant design changes can be expected. Also a ‘design criteria document’ is to be prepared for each new system. The team made a suggestion in this area.

4.7 USE OF PSA, PSR AND OEF

The station has developed a Level 1 probabilistic safety assessment (the station uses the term probabilistic risk assessment (PRA)) study for internal and external events for full power conditions as well as shut down states. A pilot case of a Level 2 PRA has been performed and development of a full Level 2 PRA is in progress. The station has developed a risk monitor, which is used to monitor risk arising from maintenance activities in refuelling outages. The PRA results are for information only rather than for risk informed decision-making.

The team observed that core damage frequency (CDF), as well as dominant contributors to the overall CDF, differs from that of a typical BWR. Although the team did not review the PRA in detail, it was observed that some initiating event frequencies are two orders of magnitude lower than internationally used values. In addition, the human reliability data used in PRA for recovery actions appears to assume substantially better human reliability than recommended in the IAEA safety standards.

The team encourages the station to follow the internationally recognized methods and practices, such as those described in the IAEA safety guide SSG-3 when developing PRA studies.

4.8 PLANT MODIFICATIONS RELATED TO POWER SUPPLY

The station has implemented comprehensive measures to enhance the AC and DC power systems to supply essential loads required under design extension conditions. These measures reflect lessons learned at Fukushima and include two diverse functions; a reliable alternate AC and DC power supply system, and a newly installed turbine-driven high pressure alternate cooling (HPAC) system. A new, dedicated battery with capacity of at least 72 hours has been installed at high elevation in the reactor building. It provides DC power to dedicated accident instrumentation and spent fuel pool water level measurement, as well as a power necessary to activate the HPAC system.

An alternate mobile unit, containing a spare battery and diesel generator charger, can be connected to the division I DC system in order to ensure continued DC power for the reactor core isolation cooling (RCIC) system. This combination of reliable AC/DC power systems and an independent and autonomous core injection is an enhancement of the original station design basis. The station is able to withstand a simultaneous loss of coolant accident (LOCA) and a station blackout (SBO). The team recognized this as a good practice.

4.9 PLANT MODIFICATIONS RELATED TO I&C

The instrumentation dedicated to severe accident mitigation strategies provides adequate measurement of critical parameters required for decision making during severe accidents. Based on a comprehensive analysis of instrument performance during the Fukushima accident, certain station instrumentation has been enhanced to provide reliable information on the status of the core and containment integrity in all situations. New instrumentation has been installed in the spent fuel pool located on the top floor of the reactor building, which provides water level information over the entire range from the top of the spent fuel pool to the bottom of the fuel assemblies.

There is an on-going, government sponsored programme in Japan to support qualification of dedicated instrumentation for severe accident conditions by testing or survivability analysis. The station has already installed this newly qualified accident instrumentation. The team recognizes this as a good performance.

4.10 EQUIPMENT QUALIFICATION

A typical station equipment qualification programme contains a set of specific activities that demonstrate and document the evidence of equipment capability to perform its safety function under anticipated operational environments during all operational states and accident conditions. Although the station does not have an equipment qualification programme, a number of components do have seismic and environmental qualification. However, the team observed that several qualification reports were dated 1981 and, since then, the station has not formally reconfirmed their validity. Some qualification reports were produced for another similar station without confirming their applicability to Kashiwazaki-Kariwa.

The initial station specific seismic data has been reviewed since the 2007 earthquake and documented in an evaluation report. Although no significant changes for the individual components were identified, the validity of the original qualification reports has not been formally documented.

In order to support an evaluation of remaining component life, the station has developed a list of electrical and I&C components for Unit 7, for which the actual ambient environmental conditions were collected during the station’s operational history. However this list does not explicitly specify what qualification status the equipment should have; for instance, the environmental qualification, the seismic qualification, the electromagnetic interference qualification. A complete list of electrical and I&C components subject to qualification still needs to be confirmed.

Although some elements of equipment qualification are in place, the team recommends that an integrated process to establish, preserve and document the equipment qualification status of safety related items that are required to function, during all plant operational states and accident conditions, is implemented.

4.12 REVISION OF DESIGN BASIS EARTHQUAKE AND TSUNAMI

The team observed that feedback of experience and lessons learnt from past events are the main drivers for updating the Design Basis Earthquake (DBE) and Tsunami (DBT), especially the 2007 Niigata-Chuetsu-Oki earthquake and 2011 Tohoku earthquake. Guidelines for earthquake assessment and for tsunami assessment on nuclear power plants were issued by the Japan Nuclear Regulatory Authority in 2013.

As a consequence, the team observed that the station has performed additional investigations to improve knowledge of the main driving parameters and to update previous earthquake and tsunami hazard assessments. The main enhancements dealing with earthquake and tsunami hazard investigations are as follows:

- Additional and extensive geological surveys at regional scale and in the site vicinity, including maritime acoustic exploration;
- Characterization of capable faults, considering an extension in time period from after 50000 years ago (until 2006) to after 120000/130000 years ago (since 2013);
- Fault activity re-assessment, including simultaneous motion of active faults (simultaneous rupture, driven by Tohoku earthquake experience feedback);
- Investigations on tsunami deposits around the station in order to find any traces of historical and pre-historical tsunamis (target range: 100 km wide, previous 10000 year: Holocene period).

The team also noted that the Japanese utilities have combined their actions through the Federation of Electric Power Companies of Japan (FEPC) since 2009 to collect domestic and international data to expand knowledge on seismic and tsunami hazards. The main outcomes of this work are reported by each utility and sent to the NRA on a yearly basis.

Based on these investigations and re-assessments, the station Design Basis Earthquake peak acceleration (at building foundation level) is now set to 0.60g to 0.87g (depending on units) and the Design Basis Tsunami wave height is now increased to 6m (8.5m considering run-up). This was identified by the team as a good performance.

4.13 SAFETY ENHANCEMENT MEASURES RELATED TO CIVIL STRUCTURES

The fundamental approach to establish new SSCs and modify existing SSCs to enhance plant safety is given in the TEPCO Master Guideline, which defines the basic philosophy toward defence-in-depth concepts on both internal and external events. This approach is deterministic.

With respect to safety enhancement measures related to an earthquake, the team observed that a comprehensive assessment of SSCs important to safety was performed to identify any necessary enhancement. The results of these investigations are compiled in a document that provides the list of safety related SSCs, the safety class and other relevant information on equipment characteristics. The result is either the justification of adequate margins in the design of the SSCs or the need to perform reinforcement actions. Significant seismic enhancement modifications have been implemented, for example:

- Enhanced existing SSCs: main exhaust stacks, spent fuel pool (sloshing protection), reactor building crane, reactor building roof structure, switching station facility, piping supports;
- New SSCs designed based on the revised DBE: sea-wall (tidal embankment), main filter equipment, mobile gas turbine generators and the technical support centre which is built on seismically isolated foundations.

Regarding safety enhancement measures related to tsunamis, a decision was taken by TEPCO after the Fukushima accident to build a protective sea-wall (tidal embankment) around the safety related area of the station, complemented by supplementary measures such as flood barriers, water tight doors and waterproofing penetrations. This set of measures was identified as a good practice by the team.

4.14 USE OF SEISMIC AND TSUNAMI PRA

The team observed that PRAs for earthquake and tsunami hazards have been performed by the station. These PRAs include the definition of scenarios, initiating events and accident sequences, probabilistic hazards assessments, fragility assessments of SSCs and final integration and evaluation of the risk. They are currently used in addition to deterministic approaches, and considered as informative.

Probabilistic Seismic Hazard Assessment (PSHA) and Probabilistic Tsunami Hazard Assessment (PTHA) are performed based on the Atomic Energy Society of Japan (AESJ) guidelines. These PSHA and PTHA develop a logic tree approach, which includes various sources of epistemic and random uncertainties.

Risk Assessments are performed for different plant situations (such as with or without taking credit for external emergency equipment) and with and without implementing enhancement measures, for example in the case of tsunami risk the presence or not of the sea wall.

The team observed that seismic and tsunami probabilistic safety assessments involve multiple departments of TEPCO Corporate and of the station (and potential suppliers). Considering the complexity of external hazard PRAs, and considering also the fact that external hazard PRAs should be performed so that uncertainties from each input are properly quantified and propagated, the team encourages the station to enhance the interface management and mutual understanding between contributors and departments involved in external hazard PRA and to perform peer reviews in an extensive manner.

DETAILED MAINTENANCE AND TECHNICAL SUPPORT FINDINGS

4.6 CONFIGURATION CONTROL

4.6 (1) Issue: A complete process to ensure availability of the design data required for design configuration control throughout the plant lifetime and design authority function has not been established.

- A complete process for maintaining the availability of plant design basis information for continuing design configuration control and integrity throughout plant life has not been established;
- Access to historical data, reliable long term storage of vendors' detailed design documentation and access to detailed design basis data have not been ensured;
- The original vendor or its subsidiary was involved in the development of systems design specifications and was used as principal supplier concerning all design changes. The Corporate Office has adopted the role of design authority and is responsible for all modifications categorized as Is, which is the highest class and represents most new design changes. However the complete role and functions of an overall design authority have not been established. In addition, TEPCO does not have guaranteed access to all necessary design basis documentation from the original supplier;
- Some safety-related modifications are performed by contractors other than the original vendor and the process of reliable long term storage and safekeeping of detailed design documentation, as well as access to detailed design basis data has not been clearly established;
- Design and installation documents submitted in relation to modifications are currently stored in the station's 'DREAMS' system, which contains some vendor's detailed documents and is accessible to station as well as corporate staff. However, completeness of the information is not guaranteed, there are some important design documents that are retained by the vendor and not submitted to TEPCO;
- Only two pilot cases on 'design criteria document' have recently been established in the Corporate Office to assure completeness of accessibility to the design basis information throughout plant lifetime.

Without a well-defined design authority role and assured reliability and availability of important plant design data throughout its lifetime, the station may have difficulties ensuring correct assessment of the safety of components and related modifications, as well as ensuring that design requirements and configuration control are properly maintained.

Suggestion: The station and Corporate Office should consider formalising their design authority function and establishing a procedure for assurance of availability of complete and reliable important plant design data, including the long term storage and safekeeping of detailed design documentation throughout the plant lifetime.

IAEA Basis:

SSR-2/1

Requirement 14: Design basis for items important to safety.

5.3. The design basis for each item important to safety shall be systematically justified and documented. The documentation shall provide the necessary information for the operating organization to operate the plant safely.

SSR-2/2

Requirement 1 Responsibilities of the operating organization.

3.2. The management system, as an integrated set of interrelated or interacting components for establishing policies and objectives and enabling the objectives to be achieved in an efficient and effective manner, shall include the following activities:

(f) Design integrity, which includes maintaining a formally designated entity that has overall responsibility for the continuing integrity of the plant design throughout its lifetime, and managing the interfaces and lines of communication with the responsible designers and equipment suppliers contributing to this continuing integrity [4].

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11. An operating organization must set up internally a formal process to maintain the design integrity as soon as it takes control of the plant. This may be achieved by setting up a design capability within the operating organization, or by having a formal external relationship with the original design organizations or their successors. There must be a formally designated entity within the operating company that takes responsibility for this process. This entity needs to formally approve all design changes. To do this, it must have sufficient knowledge of the design and of the overall basis for safety. In addition, it must have access through a formal process to all the underlying design knowledge to ensure that the original intent of the design is maintained.

4.8 PLANT MODIFICATIONS RELATED TO POWER SUPPLY

4.8(a) Good Practice: The flexibility and capability of alternate AC/DC electrical power systems to facilitate restoration of power in design extension conditions.

The alternate AC power systems consist of three mobile gas turbine units located at the +35 m elevation; a seismically qualified emergency switchgear building with a preinstalled cable connection to the unit safety buses; two 500kW mobile generators per unit that can be connected to preinstalled outside, geographically diverse connection points at the +15 m elevation and water proof emergency switchgears, located in geographically diverse places in the reactor building. The gas turbine generator has almost the same capacity as the standby AC power source that allows powering the loads necessary for the core injection and heat removal function. The gas turbine generator can be started and manually aligned to a safety bus(es) within 70 minutes.

The alternate DC power systems consist of permanent as well as transportable apparatus, preinstalled connections and portable batteries and chargers that can be deployed to ensure continuous operation of DC powered systems during accident conditions.

Both the AC and DC alternate power systems can supply power to equipment and instrumentation required during accident conditions (design basis accident and design extension conditions). The combination of the alternate AC and DC power supply systems and a newly installed High Pressure Alternate Cooling provides the Units 6 and 7 with the capability to withstand simultaneous Loss Of Coolant Accidents (LOCAs) and Station Black-Out (SBO) events.

The alternate AC and DC power systems not only meet but exceed Requirement 68 of SSR 2/1, rev. 1, as well as recommendations in Section 8: Alternate AC power Supplies of IAEA safety guide SSG-39 Design of Electrical Power Systems for NPPs (both in preparation).

4.10 EQUIPMENT QUALIFICATION

4.10(1) Issue: The plant has not established a comprehensive equipment qualification programme.

There is limited evidence of equipment qualification activities that have to be implemented, controlled and periodically reviewed, in order to ensure that throughout the plant life each installed, qualified component will function while subject to the environmental conditions during all operational states and accident conditions.

(A different situation was observed for qualification of accident instrumentation dedicated to severe accident mitigation strategies. For example, newly installed instrumentation, which provides information on the status of safety barriers and fuel inside the spent fuel pool, is being tested to severe accident conditions within the framework of a government research programme)

The team observed the following:

- An assessment that equipment important to safety is qualified for all operational states and design basis accidents through the qualified lifetime has not been fully implemented;
- An equipment qualification master list, indicating the qualification requirements for equipment located in harsh and mild environments has not been developed;
- Updated industrial standards for qualifying 'important to safety' electrical and I&C equipment has not been fully reflected for qualification of the equipment in a normally mild environment, for example in the reactor building;
- Those activities necessary for preservation of equipment qualification status are not systematically implemented.

Without an established equipment qualification programme, it cannot be confirmed that safety related equipment is capable of the required performance for all operational states and for accident conditions

Recommendation: The plant should establish and implement a comprehensive equipment qualification programme.

IAEA Basis:

SSR 2/1

Requirement 30: Qualification of items important to safety

A qualification programme for items important to safety shall be implemented to verify that items important to safety at a nuclear power plant are capable of performing their intended functions when necessary, and in the prevailing environmental conditions, throughout their design life, with due account taken of plant conditions during maintenance and testing.

5.48. The environmental conditions considered in the qualification programme for items important to safety at a nuclear power plant shall include the variations in ambient environmental conditions that are anticipated in the design basis for the plant.

5.49. The qualification programme for items important to safety shall include the consideration of ageing effects caused by environmental factors (such as conditions of vibration, irradiation, humidity or temperature) over the expected service life of the items important to safety. When the items important to safety are subject to natural external events and are required to perform a safety function during or following such an event, the qualification programme shall replicate as far as is practicable the conditions imposed on the items important to safety by the natural event, either by test or by analysis or by a combination of both.

5.50. Any environmental conditions that could reasonably be anticipated and that could arise in specific operational states, such as in periodic testing of the containment leak rate, shall be included in the qualification programme.

SR 2/2

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

4.48. Appropriate concepts and the scope and process of equipment qualification shall be established, and effective and practicable methods shall be used to upgrade and preserve equipment qualification. A programme to establish, to confirm and to maintain required equipment qualification shall be launched from the initial phases of design, supply and installation of the equipment. The effectiveness of equipment qualification programmes shall be periodically reviewed.

4.49. The scope and details of the equipment qualification process, in terms of the required inspection area(s), method(s) of non-destructive testing; possible defects inspected for and required effectiveness of inspection, shall be documented and submitted to the regulatory body for review and approval. Relevant national and international experience shall be taken into account in accordance with national regulations.

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2.10 Equipment qualification process

After equipment qualification is established, a number of NPP activities have to be implemented and controlled so that throughout the NPP lifetime each installed item of equipment reflects the requirements and limitations identified when equipment qualification was established. The preserving equipment qualification phase involves all these activities, including but not limited to:

- Equipment installation and maintenance;
- Replacement equipment and spare parts procurement;
- Plant and equipment modifications;
- Monitoring of equipment condition;
- Monitoring of service conditions;
- Trending and analysis of equipment degradation and failures;
- Evaluating other experience feedback and R&D information;
- Quality assurance;

- Documentation;
- Equipment qualification training.

4.13 SAFETY ENHANCEMENT MEASURES RELATED TO CIVIL STRUCTURES

4.13(a) Good Practice: Station protection measures against tsunami

The station has performed a comprehensive assessment of SSCs important to safety as well as those needed to cope with severe accidents to identify any necessary enhancement. The results of these investigations are compiled in a document that provides the list of safety related SSCs, the safety class and other relevant information on equipment characteristics. The result is either the demonstration of adequate margins in the design of the SSC or the need to perform reinforcement actions.

With respect to protection measures related to the tsunami risk, and based on experience and lessons learnt from the March 2011 Tohoku earthquake and Fukushima accident, the station decided to build a protection sea-wall around the safety-related area in order to keep a ‘dry’ site. As a result, all safety-related SSCs, including those needed to cope with severe accidents, are protected against a tsunami. In addition, to cope with uncertainties in tsunami wave height evaluation, a conservative height of 15m above sea level was established for the design of the sea-wall (compared with 8.5m coming from the Tsunami Hazard Assessment). Furthermore, based on the concept of Defence-in-Depth, additional measures were implemented such as flood barriers, water-tight doors and waterproofing penetrations around and/or inside the reactor building to protect safety-related SSCs in case of flooding.

These measures, implemented by the station in a pro-active way in order to improve the protection against tsunami, are an exemplary application of Defence-in-Depth and have a significant positive impact on the reduction of the risk arising from tsunamis.

6.9. EFFECTIVENESS OF OPERATING EXPERIENCE PROGRAMME

The OE programme at the station captures issues ranging from minor non-conformances identified during daily activities to more significant events that affect safety such as fires or injuries. The main reporting system is the Non-conformance system. As observed by the team, there are other reporting systems which do not process some of the key elements of an effective OE programme, for example screening, trending and analysis. Information in those reporting systems is not integrated to provide an overall view of OE programme effectiveness. Furthermore, the concept of near miss reporting is not well developed at the station.

Issues reported through the Non-conformance System are classified into four Grades (from significance levels GI (the highest), GII, GIII to X (not OE related). Investigations are required for GI and GII non-conformances (events). Two levels of investigation are implemented at the station: Root Cause Analysis (RCA), and simplified ‘why-why’ analysis. As observed by the team, the screening of events for significance and analysis does not include assessment for potential consequences. Several deficiencies were identified with regard to ‘why-why’ analysis such as absence of management procedure, insufficient extent of condition/ extent of cause analysis or delayed investigations.

All corrective actions taken with respect to events are tracked in the Non-conformance System and their implementation is assessed by the Non-conformance committee on a daily basis. The team noted that a number of actions were overdue.

The effectiveness of the OE programme is assessed in quarterly and biannual OE trending reports. As observed, OE process performance indicators are not fully developed and are not trended at station or individual departmental level. Also, the trending does not cover organizational and human factor trends in low level issues.

The external OE programme includes different sources of OE such as: IRS, WANO, INPO, JANSI, JBOG etc. These sources are screened by the relevant department at TEPCO HQ and by assigned persons at TEPCO’s nuclear power stations. New OE information is discussed among TEPCO HQ and nuclear stations on a weekly basis and the results of these discussions are used to initiate OE assessment and communication. However, the team observed that lessons learned from some significant overseas events were not sufficiently assessed for applicability.

As a result, the arrangements for an effective OE programme have not been fully developed and implemented at the station. The team issued a recommendation in this regard.

DETAILED OPERATING EXPERIENCE FEEDBACK FINDINGS

6.9 EFFECTIVENESS OF OPERATING EXPERIENCE PROGRAMME

6.9(1) Issue: The station does not use an integrated system to manage all operating experience (OE) information and some elements in the OE programme related to reporting, screening, analysis, corrective actions, trending and effectiveness reviews are not fully developed and implemented.

The team observed the following facts:

- Reporting, screening and trending of low level issues such as near misses is not consistent and comprehensive to ensure proactivity in event prevention;
- Lessons learned from some significant overseas events such as Kori, Forsmark and Arkansas Nuclear One were not used to assess existing processes and practices for improvements;
- The process of 'why-why' analysis of events (the most frequently used methodology at the station) is not described in the OE procedures. Training on 'why-why' analysis provided to station personnel was very limited in scope. In some cases, such analyses were not performed in a thorough and timely manner;
- Delayed approval of investigations in implementation of lessons learned in the field was observed;
- Several overdue corrective actions were noted by the team (some of them overdue more than 6 months);
- Screening of events for significance does not include assessment for potential consequences. A few root cause analyses are performed by the station but these are practically limited to GI events;
- Several local systems for reporting of minor issues exist at the plant, for example in Operations and Fire Protection departments. Such local systems miss some of the key elements of effective OE programmes such as screening, trending and analysis;
- OE process performance indicators are not fully developed or trended either at station or at departments' level, e.g. average age of investigations, average age of open non-conformances, % of corrective actions met on 1st deadline etc;
- Quarterly and biannual OE trending reports do not cover organisational and human factor trends in low level issue, e.g. GIII non-conformances.

Lack of an integrated system to manage internal and external OE and gaps in the OE programme related to reporting, screening, analysis, corrective actions, trending and effectiveness reviews may reduce its effectiveness in prevention of events.

Recommendation: The station should implement an integrated system to manage all operating experience (OE) information and ensure that elements in the OE programme related to reporting, screening, analysis, corrective actions, trending and effectiveness reviews are fully developed and implemented.

IAEA Basis:

SSR-2/2 – Safety of NPPs: Commissioning and operation

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

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

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.

5.30. As a result of the investigation of events, clear recommendations shall be developed for the responsible managers, who shall take appropriate corrective actions in due time to avoid any recurrence of the events. Corrective actions shall be prioritized, scheduled and effectively implemented and shall be reviewed for their effectiveness. Operating personnel shall be briefed on events of relevance and shall take the necessary corrective actions to make their recurrence less likely.

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

5.33. The operating experience programme shall be periodically evaluated to determine its effectiveness and to identify any necessary improvements.

NS-G-2.11 – A system for the feedback of experience from events in nuclear installations

3.7. The use of external operating experience can have the benefit of discovering latent potential failures that could pose concerns for safety. Such information should first be reviewed to determine whether it is applicable to the plant; this review should include consideration of aspects such as:

- …Whether there are similar practices at the plant that predispose it to similar events…

4.7. Event analysis should be conducted on a timescale consistent with the safety significance of the event. The main phases of event analysis can be summarized as follows:

- …Determination of the deviations (how it happened)…
- …Assessment of the safety significance (what could have happened)…

7. RADIATION PROTECTION

7.2 RADIATION PROTECTION POLICY

There are several mock-ups available for training of maintenance work in the training centre. This training centre can also be used to provide training on the Radiation Protection (RP) aspects of this work, such as handling the main circulation pumps, handling the control rod drives and the sipping of nuclear fuel. The team considered this a good performance.

7.3 RADIATION WORK CONTROL

The implemented radiation work permit (RWP) programme works effectively. If the anticipated collective dose from a work package exceeds 5 man-mSv, the work is evaluated jointly by TEPCO's maintenance groups and Radiation Control Group to find ways to decrease workers exposure and the amount of radioactive waste.

Small-item monitors and one line of personnel contamination monitors are placed at the boundary of the Radiation Controlled Area (RCA). The team observed that no contamination checks are done outside the RCA. There are no contamination monitors at the exit of the potentially contaminated working areas inside the RCA or before entering the toilets inside the RCA Helmets and safety shoes that are used by multiple persons are not monitored after each use. The team suggests the station consider ensuring that proper arrangements and practices for contamination control are implemented.

7.4 CONTROL OF OCCUPATIONAL EXPOURE

The station has not introduced clear individual dose constraints. The team made a suggestion to consider enhancing RP-arrangements and practices to be consistent with the ALARA principle.

Measures for minimizing and controlling radioactive leaks have been introduced. Contamination levels in the RCA are checked periodically and the air contamination is monitored by fixed aerosol monitors. System decontamination and extra confinements are also used. As an example of the effectiveness of the programme, in 1995 a leak from the off-gas system from a component left open in error was detected by the fixed aerosol monitors. This is considered by the team to be a good performance.

7.5 RADIOACTIVE WASTE MANEGMENT AND DISCHARG

The station has developed an Annual Waste Generation Plan based on the Radioactive Waste Control Basic Manual. The plan sets a goal to reduce the amount of radioactive waste generation by 20% this year. The actual accumulation of waste is monitored with a Performance Indicator (PI). The team considers this as a good performance.

7.7 RADIATION PROTECTION SUPPORT DURING EMERGENCY

Radiation protection responsibilities are defined in the station procedures and emergency experiences from the Fukushima Daiichi accident are used for improvements. The station has implemented systematic training for RP staff for emergency situations. The team observed that much effort is spent to increase the skills and knowledge of the staff, as well as on acquiring sufficient material for onsite emergency purposes. This is considered by the team to be a good practice

7.8 CHEMISTRY FACILITIES, LABORATORIES, EQUIPMENT AND INSTRUMENTS

The station has four chemistry laboratories, providing good redundancy with respect to both facilities and equipment. More equipment is also located in the Technical Support Centre (TSC) and in the training centre. Manuals and handbooks in the laboratories of units U3/U4 and U6/U7 are checked three times a week to confirm that they are appropriate and up-to-date. In other laboratories, the check is done every week. The team considered this as a good performance.

7.9 POST ACCIDENT SAMPLING SYSTEM

Normal sampling is done by the contractors. For emergency situations, the station has eight staff on-call. The team observed that there has been no estimation of the dose that could be received by the workers performing sampling tasks in the Post Accident Sampling System (PASS) room during an emergency. There are no remote handling manipulators or equivalent available in the PASS room. The team suggests the station consider enhancing the arrangements and practices to be consistent with the ALARA-principle.

7.10 QUALITY CONTROL OF OPERATION CHEMICAL AND OTHER SUBSTANCE

In the RCA, the amount of chemicals is limited to only one day´s anticipated consumption. The rest is stored in locked cabinets, close to the check-point and there is systematic book-keeping of the contents of these cabinets. The team, considered this as a good performance.

DETAILED RADIATION PROTECTION FINDINGS

7.3 RADIATION WORK CONTROL

7.3(1) Issue: the station's arrangements and practices for radioactive contamination control do not minimize the risk of undetected radioactive contamination outside the radiation controlled area or the risk of personnel contamination.

During the review the team noted the following:

- No contamination checks are done outside the RCA in order to check the potential spread of contamination;
- There are no contamination monitors at the exit of the potentially contaminated working areas inside the RCA or before entering the toilets inside the RCA;
- Helmets and safety shoes which are used by multiple persons in the RCA are not monitored after each use. Although contamination checks are done monthly on these items and the results show only very low number of contamination cases, monitoring only once per month may increase the risk of personnel contamination.

Without proper arrangements and practices for contamination control, the risk of contamination spread and personnel contamination is higher than necessary.

Suggestion: The station should consider ensuring that proper arrangements and practices for contamination control are implemented.

IAEA Bases:

GSR Part 3 Requirement 24:

Arrangements under the radiation protection programme: Employers, registrants and licensees shall establish and maintain organizational, procedural and technical arrangements for the designation of controlled areas and supervised areas, for local rules and for monitoring of the workplace, in a radiation protection programme for occupational exposure.

3.90. Registrants and licensees:

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

h) Shall periodically review conditions to assess whether there is any need to modify the measures for protection and safety or the boundaries of controlled areas;

NS-G-2.7

Workplace monitoring and surveys

3.29. The equipment to be provided for measuring radiation and activity and for sampling and analysis may include:

(d) personnel monitoring instruments, including:

(i) personnel monitoring dosimeters (some with dose rate or dose alarm devices);

(ii) contamination monitors, such as portal monitors and hand and shoe monitors;

(iii) portable monitors;

Protective clothing and protective equipment

3.53. After use, protective clothing and respiratory equipment should be considered contaminated and should be handled accordingly.

7.4 CONTROL OF OCCUPATIONAL EXPOSURE

7.4(1) Issue: Some of the station's arrangements and practices are not consistent with the ALARA principle.

During the review the team noted the following:

- No clear individual dose constraints are implemented by the station;
- There has been no estimation of the dose that could be received by RP workers performing sampling tasks in the Post Accident Sampling System room during an emergency;
- There are no remote handling manipulators or equivalent available in the PASS room for the post-accident sample handling

Without ensuring that arrangements and practices are consistent with the ALARA principle, the risk for unnecessary exposure may increase.

Suggestion: The station should consider enhancing arrangements and practices to be consistent with the ALARA principle.

IAEA Bases:

GSR Part 3 Requirement 21:

Responsibilities of employers, registrants and licensees for the protection of workers: Employers, registrants and licensees shall be responsible for the protection of workers against occupational exposure. Employers, registrants and licensees shall ensure that protection and safety is optimized and that the dose limits for occupational exposure are not exceeded.

3.77. Employers, registrants and licensees:

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

RS-G-1.1

ROLE OF DOSE CONSTRAINTS

4.17. The BSS definition [Ref. [2], Glossary] of 'dose constraint' states: 'For occupational exposures, dose constraint is a source related value of individual dose used to limit the range of options considered in the process of optimization.' A dose constraint should not be regarded as a limit, but as a minimum level of individual protection that should be achieved in a particular situation, with due regard for all the circumstances. Discussion of the nature of dose constraints is provided in a joint document by the OECD/NEA and the European Commission [16].

4.18. The objective of a dose constraint is to place a ceiling on values of individual dose — from a source, a set of sources in an installation, a practice, a task or a group of operations in a specific type of industry — that could be considered acceptable in the process of optimization of protection for those sources, practices or tasks. Depending on the situation, the constraint can be expressed as a single dose or as a dose over a given time period. It is necessary to ensure that the limits are observed if workers incur exposures from different sources or tasks.

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.

SSG-13

POST-ACCIDENT SAMPLING SYSTEM

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

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

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

8. CHEMISTRY

(Not reviewed)

9. EMERGENCY PLANNING AND PREPAREDNESS

9.1 ORGANIZATION AND RESPONSIBILITIES

The roles and responsibilities of the operating organization are clearly defined in the emergency plans. Coordination with the offsite authorities is effective both in preparedness and in response. During an emergency, two web-based tools are used to ensure a shared and common situational awareness: Common Operational Picture (COP) and an action log system, CHAT. The ability to share information amongst several response organizations in real time is considered a good practice.

This information is also recorded, serving as a record for post-accident analysis.

9.2 EMERGENCY RESPONSE

The station has introduced the Incident Command System (ICS). This is a positive improvement from the previous emergency management structure. Once units 6 and 7 are returned to service, there will be a total of 37 members of the Emergency Response Organization present on the site at all times. This provides the core capability for the Technical Support Centre (TSC) to be promptly operational. This is considered a good performance.

Emergency Action Levels (EAL) have been established for all operating conditions and the spent fuel pool. They are further subdivided into levels corresponding to various plant conditions; this facilitates communication of the plant status to the appropriate technical organization without the need for a complex technical explanation. The emergency classification system is consistent with the IAEA safety standards. However, the old system of Articles 10 and 15 is still used by some TEPCO personnel. The station is encouraged to ensure that the new emergency classification system is consistently used. The Shift Supervisor is responsible for classifying the emergency and the Site Superintendent for declaration and notification. There is no time target for classification and declaration, although the team was informed that this was expected to happen as soon as possible. The Site Superintendent has full authority to take the necessary actions to mitigate a nuclear emergency. This is clearly supported by TEPCO Headquarters.

The response to fires consists of a cascading system of fire fighting teams, with the support of external fire brigades. The procedure for receiving and dispatching the external fire brigade during an emergency is not clearly documented. This is addressed in the recommendation on plans and procedures in section 9.3.

The procedures to manage personnel accounting and the actions expected of personnel not directly assigned to the TSC and the operating crew during an emergency are not clearly documented. This is addressed in the recommendation on plans and procedures. The station is aware of this need and is conducting drills to test alternate procedures.

The equipment available for emergency workers is extensive and in very good condition. Arrangements for the medical treatment of casualties at the site and their transport to designated hospitals are clear and effective. The public relations strategy is clearly defined in the plans and is regularly tested.

There are no special provisions for managing radioactive waste during an emergency. This is being reviewed by the station.

Training of operators and some members of the TSC includes stress management; this is a considered a good performance. Although TEPCO Headquarters has arrangements for the psychological follow-up of emergency workers these are not documented in the emergency plans. Termination of an emergency is addressed in the emergency plans but the framework for transition to ‘normal’ radiation exposure conditions is not documented. These aspects are addressed in the recommendation on plans and procedures in section 9.3.

9.3 EMERGENCY PREPAREDNESS

All full-time station employees are considered Emergency Response Organization (ERO) personnel and are assigned to one of the TSC teams. This provides a substantial pool of trained personnel for the critical emergency response functions. This is considered a good performance.

The Nuclear Operator’s Disaster Management Plan addresses all key response functions and arrangements. It is supported by an extensive set of activity guides and procedures. However, several emergency functions and current practices are not fully documented. The team recommends that the station improve the current emergency plans and complete the existing emergency procedures and guides.

The TSC serves all seven units as a centre for the integrated coordination of operations and technical support to the operators. Its size is suitable to accommodate an entire ERO duty team and it has sufficient food and other supplies to sustain operations for seven days. However, the room layout and noise level could impair the effectiveness of some teams. The team suggests that the station should consider reconfiguring and improving the layout of the TSC. The team also encourages the station to continue its work to make the Safety Parameter Display System data from the simulator available in the TSC to ensure that exercises use all available tools.

The logistics support centres are fully equipped and are continuously available; they provide excellent staging areas for organizing and coordinating support to the station. Two of the centres are in the Urgent Protective Action Zone (UPZ). Provisions for the possible relocation of these centres should be included in the plans; this is addressed in the recommendation on plans and procedures. Overall, the station is well equipped to deal with all aspects of onsite emergency response. The equipment includes, for example, 42 fire engines, seven seawater heat-exchange vehicles, three concrete pumps, heavy machinery for debris removal, approximately 1000 extra APDs, several hand-held two-way radios, satellite communications and portable toilets. The station has also certified a large number of staff on the operation of heavy machinery for debris removal during an emergency.

The station has an extensive monthly drill and exercise programme for the entire ERO in a broad range of realistic scenario types. The team considered this as a good practice.

DETAILED EMERGENCY PLANNING AND PREPAREDNESS FINDINGS

9.2 EMERGENCY RESPONSE

9.2(a) Good Practice: Common situational awareness enhancement tools

The operating organization of Kashiwazaki-Kariwa Nuclear Power Station has introduced an innovative system that could greatly alleviate the risk associated with different response organisations having different and incomplete awareness of plant status and response during an emergency.

The coordination of technical and operational information is harmonized and synchronized through an information management system consisting of the Common Operational Picture (COP) web-based platform and the common CHAT communications web-based platform, which capture up-to-date information about plant status, emergency actions and major decisions. he COP and CHAT information is shared between all operational organizations, including the station, the municipal and prefecture authorities, TEPCO headquarters and the Nuclear Regulatory Agency.

This greatly enhances the overall situational awareness of all organizations involved in the emergency response. It allows them to perform a consistent assessment, to communicate consistent information and to take consistent actions.

This system has proven very effective in exercises.

9.3 EMERGENCY PREPAREDNESS

9.3(1) Issue: The emergency plans and procedures do not fully and clearly document what is done in practice.

The team observed the following:

- Many response concepts or requirements are covered in different documents or working tools. The Nuclear Operator's Disaster Management Plan provides a good and comprehensive basis that addresses all key response functions but the concepts of operations are not completely described. ;
- The emergency response procedure for chemical and some external events (such as forest fire) is not clearly documented;
- The time target for emergency classification of an event and declaration of an emergency is not specifically stated, although it is acknowledged that the procedures call for prompt response by the shift supervisor and the site superintendent;
- The procedure for accounting for all personnel during an emergency is not clearly documented and may not ensure that missing and potentially injured personnel can be identified and located within a short time;
- The basic actions of all personnel (including contractors) at the site (other than TSC and operating shifts) during an Alert, Site Emergency or General Emergency, as well as the site personnel evacuation arrangements (for all staff and contractors) are not documented;
- There is no procedure detailing what equipment personnel evacuated to the logistics support centres must bring with them;
- The arrangements for receiving the external fire brigade at the site during an emergency are not clearly documented. This includes the selection of an appropriate dose alarm level for the dosimeters to be provided by the station, and the location at which the brigade should meet the Emergency Response Organization staff;
- The arrangements for transition to an existing exposure situation (recovery and transition to 'normal') are not clearly documented;
- The arrangements on the use of logistics support centres in the Urgent Protective Action Zone and the possible need to relocate them when they could be affected by a significant release are not documented in the plan or procedures;
- The management of post-emergency care of emergency workers is not documented.

A lack of clarity in the emergency plans and procedures can lead to inconsistencies in the response and can reduce the effectiveness of the emergency response arrangements.

Recommendation: The station should improve the current emergency plan (Nuclear Operator's Disaster Management Plan) to ensure that it contains all the basic arrangements and concepts of operation for all key emergency response functions, and should also complete the existing emergency procedures and guides to ensure that they are comprehensive, clear, consistent, unequivocal and standardized.

IAEA Basis:

GSR-2

5.14. Each response organization 'shall prepare a general plan or plans for co-ordinating and [performing their assigned functions as specified in Section 4].

'Emergency plans shall be prepared which specify how the responsibilities for the management of interventions will be discharged on the site…'

5.18. Emergency plans shall include, as appropriate:

a. Allocation of responsibilities for [performing the functions specified in Section 4];
b. Identification of the various operating and other conditions [...] which could lead to the need for intervention;
c. Intervention levels, […];
d. Procedures, including communication arrangements, for contacting any relevant [response organizations] and for obtaining assistance from fire fighting, medical, police and other relevant organizations;
e. A description of the methodology and instrumentation for assessing the [nuclear or radiological emergency] and its consequences on and off the site;
f. A description of the public information arrangements in the event of [a nuclear or radiological emergency]; and
g. The criteria for terminating each protective action.

5.19. The operating organization … shall prepare an emergency plan that covers all activities under its responsibility, to be adhered to in the event of an emergency …

5.20. The emergency plan of the operating organization … shall include the following [as appropriate]:

(1) A description of the on-site organization used to perform the functions specified in Section 4, including the] designation of persons for directing on-site activities and for ensuring liaison with off-site organizations;

(2) The conditions under which an emergency shall be declared, [including the criteria for classification] a list of job titles and/or functions of persons empowered to declare it, and a description of suitable [arrangements] for alerting response personnel and public authorities;

(3) The arrangements for initial and subsequent assessment of the [conditions at the facility and] radiological conditions on and off the site;

(4) [Arrangements] for minimizing the exposure of persons …;

(5) Assessment of the state of the facility and the actions to be taken on the site to limit the extent of [any] radioactive release;

(6) The chain of command and communication …

(7) An inventory of the emergency equipment to be kept in readiness at specified locations;

(8) The actions to be taken by persons and organizations involved in the implementation of the plan …

(9) Arrangements for declaring the termination of an emergency.

GS-G-2.1

6.1. The Requirements … require each response organization to prepare an emergency plan for coordinating and performing their assigned response functions. As defined in the IAEA Safety Glossary, an emergency plan should contain a concept of operations.

6.2. The concept of operations should be a brief description of the ideal response to an emergency.

9.3(2) Issue: The Technical Support Centre (TSC) room layout does not provide an optimal environment for the work of the Emergency Response Organization.

The team observed during an exercise conducted on 29 June that:

- The noise level in the TSC was disruptive to command and control of the TSC;
- The Planning Team which, amongst other tasks, supports the operating crew by giving advice on Severe Accident Management Guidelines (SAMG) to deal with complex situations needs space and quiet to discuss SAMG strategies. However, it was disrupted by personnel traffic in their space and by the noise level. Furthermore, the Planning Team has no wall or boards on which to either project or post system diagrams for discussion and brainstorming;
- The command team had difficulty discussing issues due to the noise level and high traffic of personnel in their area;
- The projection screens and other visual aid tools were not effectively used (for example to display current operational priorities);
- The large space in the centre of the room was not used effectively.

Without an effective TSC layout the Emergency Response Organization may not be able to effectively manage and coordinate the emergency response.

Suggestion: The station should consider reconfiguring and improving the layout of the TSC on the basis of operating experience and drills and design of other similar facilities.

IAEA Basis:

GS-R-2

5.25. Adequate … facilities and documentation (such as procedures, checklists, telephone numbers and manuals) shall be provided for performing the functions specified in Section 4. These items and facilities shall be selected or designed to be operational under the postulated conditions (such as the radiological, working and environmental conditions) that may be encountered in the emergency response, and to be compatible with other procedures and equipment for the response (such as the communication frequencies of other response organizations), as appropriate.

GS-G-2.1

VIII.1. … the functions of and operational conditions and requirements for the facilities or locations should be carefully considered, and necessary advance preparations should be made. Facilities or locations established in advance (e.g. the technical support centre for a nuclear power plant) are designed, built and equipped to support their functional and operational requirements. […]

VIII.2. Each emergency facility or location should be:

- Designed to support the functions that take place within it;
- Usable under emergency conditions;
- Integrated into the incident command system.

9.3(a) Good Practice: Intensive Emergency Response Organization exercise programme

The station has implemented a detailed programme of monthly exercises for the full Emergency Response Organization.

The exercise scenarios systematically cover a wide range of severe conditions and complex challenges. Exercises are conducted to simulate, to the extent practicable, realistic conditions. This includes exercises conducted in low light level conditions (to simulate loss of normal lighting during SBO conditions and events during the hours of darkness) and using protective equipment that would be used during extreme weather conditions such as very high rainfall (to practice performing activities that could be hindered by the additional protective equipment

The results of the detailed programme of exercises and the high degree of realism gives greater confidence that the station ERO will be able to discharge its responsibilities in all credible accident conditions,

10. SEVERE ACCIDENT MANAGEMENT

10.1 ORGANISATION AND FUNCTIONS

Responsibilities, authorities, and functions for the Accident Management Programme are clearly defined at the station. The Plant Operations Group has overall responsibility for the development of Severe Accident Management Guidance (SAMG) used by control room operators. This includes both Emergency Operating Procedures (EOPs) and Severe Accident Operating Procedures (SOPs) used by operators in the main control room. The operations department assigns one experienced plant operator at each unit to maintain the EOPs/SOPs. These operators maintain proficiency on EOPs/SOPs by participating in both classroom and simulator training. Accident Management Guidance (AMG) used by the Planning Team in the TSC is developed and maintained by the Safety Engineering Administrative Group.

A good practice was identified in the TQ area by the team with regard to the significant commitment made by the station to using training to improve performance and ensure a high state of readiness in response to design extension conditions and large scale events.

10.2 OVERVIEW OF SEVERE ACCIDENT MANAGEMENT PROGRAMME

SAMG is broadly based on US BWR Owner's Group (BWROG) Emergency Procedure Guidelines/Severe Accident Guidelines (EPG/SAG). TEPCO corporate has partnered with the other Japanese BWR Electric Power Companies and Japanese BWR manufacturers (Hitachi-GE, Toshiba) to modify the BWROG EPGs/SAGs into a generic SAMG for Japanese BWRs which is then converted into a plant specific SAMG by each nuclear power station. Partnering with Toshiba and Hitachi-GE ensures strong engagement by the plant designers and key suppliers.

Members of the TEPCO HQ staff actively participate in the Boiling Water Reactor Owner's Group (BWROG). They have plans to work with the consortium of Japanese utilities and vendors to incorporate the latest versions of the BWROG EPG/SAG into the Japanese generic accident management templates by the end of 2016.

TEPCO has made a significant investment in plant modifications to support the response to design extension conditions and enhance Defence-In-Depth (DID). This includes permanent design improvements such as a filtered primary containment vent, extensive external and internal flood barriers, passive H2 recombiners and strengthening the electrical power capacity of DC power systems. Extensive portable equipment has been procured to support alternate supply of makeup water to the reactor, containment, and spent fuel pool. The above actions to strengthen DID is considered as a good practice by the team.

10.3 ANALYTICAL SUPPORT FOR SEVERE ACCIDENT MANAGEMENT

The station EOPs/SOPs/AMGs was developed from generic guidance developed by the BWROG and the consortium of BWR Japanese Electric Power Companies and BWR designers (Toshiba and Hitachi-GE). The generic guidance was developed from information from the EPRI Severe Accident Management Guidance Technical Basis Report, from other published analyses and reports and from generic Individual Plant Examinations (IPEs) for each BWR product line.

Level 1 PSA has been performed for Units 6 and 7 and was used to validate work performed in the development of generic SAMGs. Level 1 PSA analysis was performed using MAAP 3b. Efforts to update AMG are currently underway including analysis using MAAP 5 which allows for more comprehensive assessments of core damage and radiological transport. This work will be used to update the SAMGs in November 2015.

Level 2 PSA has been performed to evaluate measures and actions to mitigate severe accident conditions. PSA insights have been incorporated into accident management guidance and proactively used as inputs during the conceptual stage of design modifications. PSA results show that TEPCO has been able to substantially reduce CDF by the modifications that have been implemented for design extension conditions, specifically earthquakes and tsunami.

Containment bypass failure mode is considered in the station PSA analysis. The analysis provides insights on mitigating actions, namely limiting containment over pressure, spraying the containment atmosphere or flooding the containment to cover the breach.

A Level 1 Fire PSA is currently in progress. The team encourages the station to complete this effort and ensure that key insights are reflected in plant accident management guidance.

Insights from PSA analysis have also been compiled in the AMG and are used by the Planning Team in the TSC during emergencies. Computational aids included in the AMG allow for the quick assessment of plant conditions by the Planning Team which is then used to provide feedback on the effectiveness of operator actions. These aids were identified as a good practice by the team.

10.4 DEVELOPMENT OF PROCEDURES AND GUIDELINES

Severe accident management guidance (EOPs/SOPs) provides direction to control fission product barriers including the reactor pressure vessel (RPV) and primary containment vessel (PCV). The symptom-based response strategies prescribed in SAMG maintain the reactor plant in a safe condition without requiring diagnosis of the initiating event. No risk or probability threshold is defined and every effort has been made to address any mechanistically possible condition with appropriate operational guidance to minimize the impact on public health and safety. SAMG entry conditions and parameters controlled are directly measurable with available control room instrumentation.

The EOPs and SOPs function together as an integrated set of instructions. The EOPs define strategies for responding to emergencies and events that may degrade into emergencies up until it is determined that the core cannot be adequately cooled. Each EOP protects one of the principal barriers to radioactivity release through control of key plant parameters. EOP contingencies form extensions to the top-level guidelines, providing more detailed instructions for controlling individual parameters under more degraded conditions. The SOPs extend the EOPs still further, addressing severe accident conditions, defining the strategies applicable after it is determined that the core cannot be adequately cooled.

Priorities are described in the bases documents for each of the EOP/SOP development procedures and cover both the preventive and mitigation domains.

The purpose and priorities of the RPV control guideline and associated contingencies are to: maintain adequate core cooling, shutdown the reactor, stabilize RPV pressure and, if necessary, cool down the RPV to cold shutdown conditions. The primary objective is to restore and maintain RPV water level above the top of the active fuel. This goal is achieved through use of all available injection sources and, if necessary, emergency RPV depressurization. If adequate core cooling cannot be ensured, SOP entry is required.

The purpose and priorities of the PCV control guideline are to maintain primary containment integrity and protect equipment in the primary containment.

The purpose and priorities of the SOPs are to remove heat from the RPV, retain core debris in the RPV, maintain primary containment integrity, scrub fission products from the containment atmosphere, prevent or minimize core-concrete interaction, and submerge the core and core debris.

The station has made extensive efforts to ensure instrument survivability during accident conditions. At least one channel of instrumentation has been hardened to ensure that it is qualified and available for use in severe accident conditions for all key RPV and PCV parameters.

The team noted that the current EOPs/SOPs provide guidance only for the operating regime and that guidance is not provided for a few abnormal conditions. The team suggests that the station updates these documents with the objective of extending their scope to shutdown operational regimes and the occurrence of an accident in the spent fuel pool under design extension conditions. Although the plant has developed some response guidance which is currently found in AOPs and the Tsunami AMG, this guidance needs to be formally integrated into the EOPs/SOPs. The team also suggests that the station enhance the EOPs/SOPs with the addition of guidance to control secondary containment parameters and consider the use of methods for alternate boron injection during situations in which Standby Liquid Control System may fail to operate.

10.5 PLANT EMERGENCY ARRANGEMENTS WITH RESPECT TO SAM

The station maintains a Technical Support Centre which is organized using the Incident Command System (ICS). Three teams of qualified TSC HQ personnel are in place and 45 individuals are assigned to the Planning Team with 9 (a part of ICS functions) required to achieve minimum staffing levels. The team approach is designed to minimize the impact of stress from extended duration staffing periods.

The TSC is located in a seismically isolated building which has a dedicated HVAC system powered by an independent Gas Turbine Generator (GTG). The HVAC System maintains the TSC at a positive pressure relative to the outside environment. Lead shielding is provided in aprons hung from windows in the TSC to provide additional radiological shielding. Although not missile protected, windows in the TSC are covered with a protective coating to prevent shattering.

Facilities, instruments, tools, equipment and communication systems are maintained through preventive and, when necessary, corrective maintenance programmes.

The station maintains a significant amount of portable equipment stored in designated elevated locations. Response to multi-unit events is provided by having sufficient equipment to support response at all seven units concurrently. An abundant supply of hoses used for portable makeup to the reactor, containment, and spent fuel pool exists for all units at the station. The team encourages the station to ensure that adequate testing programmes are in place for hoses that are maintained in inventory.

Robust communication options have been provided which include phones, satellite phones, cell phones, microwave communications, fibre optic lines and radios. This provides diversity and ensures that key emergency groups can maintain communications during events. Communication systems have been hardened and provisions are in place to provide backup power to systems as needed. The sharing of information during an event is supported by use of the Common Operational Picture (COP) web-based platform and the common CHAT communications web-based platform, which capture up-to-date information about plant status and about emergency actions and major decisions. These communication systems were considered as a good practice by the team.

10.6 VERIFICATION AND VALIDATION OF PROCEDURES AND GUIDELINES

Expectations for verification and validation are specified in Operation Manual NM-51-5. Verification practices assess both the technical adequacy and usability of procedures and guidelines.

Each operating crew is given the opportunity to validate EOP/SOP changes. The crews are given copies of the changes and review them during crew 'Family' training. Simulators are typically used for validation. The simulators are able to model severe accident conditions. This is considered a good performance by the OSART team. Drills are used to practice execution of the guidance including time response, use during hazardous conditions, and under stress.

The team suggests that the station consider developing a more formal validation programme that includes validation of time critical operator actions, involves multi-discipline teams observing the operators using the procedures being validated, and assesses the impact of changes on the organizational aspects of SAM, especially the roles of the evaluators and decision makers in the TSC.

10.7 CONTROL OF PLANT CONFIGURATION

Consistency between design requirements, physical configuration, and plant documentation is accomplished by the involvement of key station groups in EOP/SOP/AMG revisions. The impact of plant modifications and changes in available mobile equipment is assessed. The operations department independently tracks each modification to ensure that drawings are updated and procedures are revised.

Processes are in place to update the SAMGs when new information on severe accident management becomes available. TEPCO corporate is the primary interface with external groups and research organizations. TEPCO actively participates in the BWROG Emergency Procedures Committee and Fukushima Response Committee and works with many other scientific and technical groups on research and analysis of the Fukushima Daiichi accident.

10.8. USE OF PSA, PSR AND OEF

Level 1 and Level 2 PSA have been performed and used for the identification of sequences that may lead to severe accidents and offsite releases. PSA insights have been incorporated into accident management guidance and proactively used as inputs during the conceptual stage of design modifications. These have demonstrated a significant reduction in Core Damage Frequency for design extension conditions, specifically earthquakes and tsunami.

PSA and other analyses have been used proactively to determine the potential benefits of design modifications in the conceptual stage of design. This is considered as a good practice by the team. As an example, preliminary analysis performed indicated a substantial reduction in dose would be achieved for operators in the MCR and response workers in the field if a combination of filtered vent, iodine filter, and pH control in the primary containment was established. Based on these insights, an iodine filter is being installed and a system is being designed to inject sodium hydroxide into the suppression pool using the MUWC system.

DETAILED SEVERE ACCIDENT MANAGEMENT FINDINGS

10.3 ANALYTICAL SUPPORT FOR SEVERE ACCIDENT MANAGEMENT

10.3(a) Good Practice: Use of computational aids to support event response

Computational aids have been developed for use by the Planning Team in the TSC to allow for the quick assessment of plant conditions and to provide feedback to operations on the effectiveness of operator actions.

As examples:

- The Accident Management Guidelines contain results of sensitivity studies which includes an assessment of the benefits and consequences of key operator actions;
- A software tool was created to calculate the time to ‘Top of Active Fuel’ based on input of scram time, current RPV injection rate, RPV level, RPV pressure and PCV pressure. The output was validated against data provided in the simulator model which is based on MAAP and provided comparable results;
- A software tool was developed to evaluate the effects of increases in Spent Fuel Pool (SFP) water temperature based on input of current temperature and level. If SFP cooling is lost, the model calculates the time to reach Tech Spec Limits and the time to boil. The software also provides graphs of forecasted SFP level;
- A software tool has been developed to estimate the time that the PCV will need to be vented and the release amount. The software also models H_2 generation prior to and after RPV breach. This is being tested and will be implemented in the AMGs.

These computational aids allow the TSC to make timely and consistent assessments of important accident parameters resulting in direction of effort towards actions that will more likely minimise the consequences of the accident. The time projections provided by these aids allows rapid feedback to operations and the TSC command structure on whether actions taken are likely to achieve their intended objectives

10.4 DEVELOPMENT OF PROCEDURES AND GUIDELINES

10.4(1) Issue: Accident management guidance and associated procedures do not include the shutdown mode and some abnormal conditions.

- Conditions for entry into the severe accident mitigation domain only consider plant states with the reactor at power operation; they do not address shutdown conditions;
- Some guidance for the control of secondary containment challenges is provided in station abnormal operating procedures. However, guidance for the control of secondary containment parameters is currently not in the EOPs/SOPs. Industry standards are to have this integrated into the EOPs/SOPs since it is protecting a fission product barrier;
- Guidance for the control of SFP level is provided in station alarm response procedures and abnormal operating procedures. In addition, Tsunami accident management guidance has been developed which utilizes portable equipment to respond to SFP events. However, the EOPs/SOPs have not been revised to reflect these accident management strategies;
- The criteria for transitioning between the EOPs and SOPs are currently based on the evaluation of core damage using Containment Atmosphere Monitoring System (CAMS). They do not include the indication of RPV water level when it is available. Using RPV water level has the additional benefit of providing another option to operators in the event that the CAMS is inoperable;
- The EOPs do not have a provision for Alternate Boron Injection as a means to shutdown the reactor when Standby Liquid Control System (SBLC) is not operable as an additional option for reactivity control.

Following a possible severe accident, the absence of comprehensive EOPs/SAGs can leave the station staff in a complex plant situation under high stress conditions without appropriate guidance, possibly leading to inadequate responses.

Suggestion: The station should update the EOPs/SOPs/AMG with the objective of extending their scope to shutdown operational regimes and the occurrence of an accident in the spent fuel pool under design extension conditions. Although the station has developed some response guidance which is currently found in AOPs and the Tsunami AMG, this guidance needs to be formally integrated into the EOPs/SOPs.

IAEA Basis:

NS-G-2.15

2.11. For any change in the plant configuration or if new results from research on physical phenomena become available, the implications for accident management guidance should be checked and, if necessary, a revision of the accident management guidance should be made.

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 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.

2.17. Severe accident management should cover all modes of plant operation and also appropriately selected external events, such as fires, floods, seismic events and extreme weather conditions (e.g. high winds, extremely high or low temperatures, droughts) that could damage large parts of the plant. In the severe accident management guidance, consideration should be given to specific challenges posed by external events, such as loss of the power supply, loss of the control room or switchgear room and reduced access to systems and components.

2.18. External events can also influence the availability of resources for severe accident management… Such possible influences should be taken into account in the development of the accident management guidance.

3.111. For any change in plant configuration, the effect on EOPs and SAMGs as well as on organizational aspects of accident management should be checked. A revision of the documents should be made if it is found that there is an effect on these procedures and guidelines.

10.6 VERIFICATION AND VALIDATION OF PROCEDURES AND GUIDELINES

10.6(1) Issue: The validation of EOP/SOP changes to ensure that they can be executed is performed in an informal manner by the operating crews only.

- The station does not have a formal time-critical operator action programme to ensure that time-critical operator actions identified in analysis are appropriately identified in procedures and validated;
- The validation programme does not include detailed validation checklists and specific requirements for how validation is performed;
- Validation typically includes a multi-discipline team observing operators in the simulator; however at Kashiwazaki-Kariwa Units 6 and 7 this is performed informally by the operating crews only;
- Validation does not formally test the organizational aspects of SAM, especially the roles of the evaluators and decision makers in the TSC.

Lack of rigor in the validation process could result in operators and ERO personnel facing challenges with the implementation of accident management guidance during actual plant events. The validation process serves as the final check that accident management guidance is usable by the end users.

Suggestion: The station should consider developing a more formal validation programme that includes validation of time critical operator actions.

IAEA Basis:

SSR-2/2 6.9:

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

NS-G-2.15

3.99. All procedures and guidelines should be verified. Verification should be carried out to confirm the correctness of a written procedure or guideline and to ensure that technical and human factors have been properly incorporated. The review of plant specific procedures and guidelines in the development phase, in accordance with the quality assurance regulations, forms part of this verification process. In addition, independent reviews should be considered, where appropriate, in order to enhance the verification process.

3.100. All procedures and guidelines should be validated. Validation should be carried out to confirm that the actions specified in the procedures and guidelines can be followed by trained staff to manage emergency events.

3.101. Possible methods for validation of the SAMGs are the use of a full scope simulator (if available), an engineering simulator or other plant analyser tool, or a tabletop method. The most appropriate method should be selected. nsite tests should be performed to validate the use of equipment. Scenarios should be developed that describe a number of fairly realistic (complex) situations that would require the application of major portions of the EOPs and the SAMGs. The scenarios encompass the uncertainties in the magnitude and timing of phenomena (both phenomena that result from the accident progression and phenomena that result from recovery actions).

3.102. Members of staff involved in the validation of the procedures and guidelines should not be those who developed the procedures and guidelines.

10.8 USE OF PSA, PSR, AND OEF

10.8(a) Good Practice: Using analysis proactively to enhance plant design for design extension conditions

PSA and other analyses have been performed to determine the potential benefits of design modifications in the conceptual stage of design.

As an example, preliminary analysis performed indicated a substantial reduction in dose would be achieved for operators in the MCR and response workers in the field if a combination of filtered vent, iodine filter, and pH control in the primary containment was established.

Based on these insights, an iodine filter will be installed and a system is being designed to inject sodium hydroxide into the primary containment using the MUWC system for pH control.

This proactive analysis is expected to significantly improve on and off site does in the event of a severe accident, alleviating emergency response and reducing dose.

DEFINITIONS

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 on-going 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 does not quite 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 1** Governmental, Legal and Regulatory Framework for Safety (General Safety Requirements)
- **GSR Part 3;** Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, Interim Edition
- **GSR Part 4**; Safety Assessment for Facilities and Activities (General Safety Requirements 2009)
- **GSR Part 5**; Predisposal Management of Radioactive Waste (General Safety Requirements)
- **SSR-2/1**; Safety of Nuclear Power Plants: Design (Specific Safety Requirements)
- **SSR-2/2**; Safety of Nuclear Power Plants: Operation and Commissioning (Specific Safety Requirements)
- **NS-G-1.1**; Software for Computer Based Systems Important to Safety in Nuclear Power Plants (Safety Guide)
- **NS-G-2.1**; Fire Safety in the Operation of Nuclear Power Plans (Safety Guide)
- **NS-G-2.2**; Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants (Safety Guide)
- **NS-G-2.3**; Modifications to Nuclear Power Plants (Safety Guide)
- **NS-G-2.4**; The Operating Organization for Nuclear Power Plants (Safety Guide)
- **NS-G-2.5**; Core Management and Fuel Handling for Nuclear Power Plants (Safety Guide)
- **NS-G-2.6**; Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants (Safety Guide)
- **NS-G-2.7**; Radiation Protection and Radioactive Waste Management in the Operation of Nuclear Power Plants (Safety Guide)
- **NS-G-2.8**; Recruitment, Qualification and Training of Personnel for Nuclear Power Plants (Safety Guide)
- **NS-G-2.9**; Commissioning for Nuclear Power Plants (Safety Guide)
- **NS-G-2.11**; A System for the Feedback of Experience from Events in Nuclear Installations (Safety Guide**)**
- **NS-G-2.12**; Ageing Management for Nuclear Power Plants (Safety Guide)

- **NS-G-2.13**; Evaluation of Seismic Safety for Existing Nuclear Installations (Safety Guide)
- **NS-G-2.14**; Conduct of Operations at Nuclear Power Plants (Safety Guide)
- **NS-G-2.15**; Severe Accident Management Programmes for Nuclear Power Plants Safety Guide (Safety Guide)
- **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)
- **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)
- **GS-G-4.1**; Format and Content of the Safety Analysis report for Nuclear Power Plants (Safety Guide 2004)
- **SSG-2**; Deterministic Safety Analysis for Nuclear Power Plants (Specific Safety Guide 2009)
- **SSG-3**; Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants (Specific Safety Guide 2010)
- **SSG-4**; Development and Application of Level 2 Probabilistic Safety Assessment for Nuclear Power Plants (Specific Safety Guide 2010)
- **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
- **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 Radionuclides (Safety Guide)
- **RS-G-1.3**; Assessment of Occupational Exposure Due to External Sources of Radiation (Safety Guide)
- **RS-G-1.8**; Environmental and Source Monitoring for Purpose of Radiation Protection (Safety Guide)
- **SSR-5;** Disposal of Radioactive Waste (Specific Safety Requirements)

- **GSG-1** Classification of Radioactive Waste (Safety Guide 2009)
- **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, (Updating IAEA-TECDOC-953)

- **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)

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