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REPORT

OF THE

OSART

(OPERATIONAL SAFETY REVIEW TEAM)

MISSION

TO THE

DOEL
NUCLEAR POWER PLANT
(BELGIUM)

8-25 March 2010

DIVISION OF NUCLEAR INSTALLATION SAFETY
OPERATIONAL SAFETY REVIEW MISSION
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PREAMBLE

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

FOREWORD

by the

Director General

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

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

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

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

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

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

CONTENT

INTRODUCTION AND MAIN CONCLUSIONS

INTRODUCTION

At the request of the government of the Kingdom of Belgium, an IAEA Operational Safety Review Team (OSART) of international experts visited Doel Nuclear Power Plant from 8 to 25 March 2010. The purpose of the mission was to review operating practices in the areas of Management organization and administration; Training and qualification; Operations; Maintenance; Technical support; Operating experience, Radiation protection; Chemistry and Emergency planning and preparedness. In addition, an exchange of technical experience and knowledge took place between the experts and their plant counterparts on how the common goal of excellence in operational safety could be further pursued.

The Doel OSART mission was the 157th in the programme, which began in 1982. The team was composed of experts from France, China, United Kingdom, United States of America, Switzerland, Sweden, Canada, Finland, and Hungary together with the IAEA staff members and observers from Czech Republic and Russia. The collective nuclear power experience of the team was approximately 378 years.

The Doel nuclear power plant is located in the Port of Antwerp, on the Schelde river, a few kilometers from the border between Belgium and the Netherlands. The plant is owned principally by Electrabel which belongs to the GDF SUEZ Group. The plant has 961 Electrabel employees and about 350 permanent contractor staff on site.

The plant operates units 1 and 2 with 433 MWe net power each and units 3 and 4 with 1006 and 1040 MWe net power respectively. According to the request of the Federal Agency for Nuclear Control (FANC) units 1 and 2 were the main scope of the OSART review. Doel 1 and 2 are twin units with two loop PWR reactors; they share various common safety systems and a common control room. The Architect Engineer for Doel 1 and 2 were Tractionel (now Tractebel) Engineering and Electrabel using a Westinghouse licence. Doel 1 and 2 started commercial operation in 1975. A common bunker with emergency systems was constructed in 1990. Steam generators were replaced on Doel 2 in 2004 and on Doel 1 in 2009.

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

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

The following report is produced to summarise the findings in the review scope, according to the OSART Guidelines document. The text reflects only those areas where the team considers that either 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 team concluded that the management of Doel NPP are committed to the principle of continuous improvement in the operational safety and reliability of their plant.

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

- Self assessment exercises are conducted at all levels, including workshop level, as well as at different process levels;
- Competency grades are used to measure safety culture and reduce errors due to human behavior;
- The defense-in-depth principle as a strategy for nuclear safety is integrated into all training courses and programs;
- A training and assessment program is performed to improve contractors' competency in Nuclear Safety Culture during outages;
- An intensive training program is used for maintenance work planners, leading to a formal accreditation;
- The fuel department has compiled a pocket size book that is easy to use and provides a short and easy to read description of tools, equipment and installations used for handling of fuel and core components.

A number of areas for improvements in operational safety were identified by the team. The most significant of them include the following:

- Analyses for some events are not being performed to the required depth and rigor described in the plant programs, and are not being completed in a timely fashion;
- Outside of working hours, there is no one required to be present at the site who has the responsibility or the authority to classify an emergency or to notify off-site authorities;
- Not all industrial safety related hazards and risks to workers' safety and health are identified and eliminated on an ongoing basis;
- The plant uses Probabilistic Safety Analyses to a limited extent for assessments and risk evaluations;
- Procedural guidance is not currently in place to ensure the control room environment remains habitable by operators with respect to oxygen content following an accident;
- There are weaknesses in the maintenance backlog management tool and the methodology for ensuring timely completion of maintenance works.

Doel NPP management expressed a determination to address the areas identified for improvement and indicated a willingness to invite a follow up visit some time in the beginning of 2012.

1. MANAGEMENT, ORGANIZATION AND ADMINISTRATION

1.1. ORGANIZATION AND ADMINISTRATION

The Human Resources programme is based on a strategic workforce plan, which has involved significant recruitment of new employees in the past few years. It is very comprehensive, and includes a five-year staffing plan and deployment policy, as well as provisions for development and motivation of employees (welcome and integration, competency management, career management, mobility, retention).

In the manpower plan, each position is linked to a function in a job catalogue, with specification of the required skills (both behavioral and operational). An extensive training program for new staff focused on each individual’s specific needs has been implemented. The team considers this a good performance in Human Resources management.

The plant has undergone a significant renewal of internal human resources, and uses many contractors: 350 permanent contractors, 2,000 during major outages. However problems were observed in contractors performance in the area of industrial safety and quality control after performance of work. The team encourages the plant to continue its efforts in integration and commitment of contractors in this area.

External communication is based on a “commitment to the local community”, consisting of safe operation, responsibility to the public and the local environment, openness and transparency. Efforts have been made to achieve a good level of communication (new information centre, information magazine, website, yearly publication of safety and environmental results). Regular surveys are carried out to understand the perception of the public around the plant on nuclear energy. The team considers this to be a good performance.

1.2. MANAGEMENT ACTIVITIES

The plant has an objective-setting process by which plant objectives are set annually on the basis of various factors including self-assessment and management reviews and independent plant safety management evaluations. Based on these, department and individual objectives are set and monitored on regular intervals. The team considers this process as a good performance.

Communication at the plant is structured and focused on nuclear safety and is targeted at plant employees and contractors. Several initiatives and tools such as safety behavior campaigns, reporting on safety concerns through management expectation leaflets, “face to face” communication (monthly team meetings), and a monthly internal magazine are used. The team considers this as a good performance.

The plant has introduced a well-structured Human Error reduction program based on evaluation of risk and error precursors and use of error reduction tools. The team considers this a good performance.

The team has recognized the use of competency grades to measure safety culture and reduce errors due to human behavior as a good practice.

1.3. MANAGEMENT OF SAFETY

During the review the team noted several work practices, situations and conditions which can be considered as an indication of safety culture at the plant.

The positive safety culture features include the following items:

- A culture of open communication existing within the plant organization.

  Notable example was the discussions of the plant staff with the team on the issue of control room habitability, during which an open and free dialogue took place among the plant staff belonging to various organization levels without any inhibition from the hierarchy order.

- Expectations on Nuclear Safety are clearly established and professionally communicated in the plant.

  The corporate policy statement declares "Safety is the first priority' which has precedence over production in all circumstances. The team observed evidence of implementation of this policy in the field in terms of; safety related work orders being clearly identified at beginning of work preparation phase with support of a dedicated database and also existing provision of organizing specific meetings in case of non frequent situations with safety impacts.

- The plant makes an extensive use of internal and external assessments and self-assessment for safety improvements.

  These assessments are regularly done at various levels of organization (from department to individual) and the team observed this being done exceptionally well for the fuel and chemistry department. Use of "yellow sticky exercise" tool for self-assessment was identified as good practices by the team and this is worth emulating by the industry.

- Management has set very clear expectation for its staff and contractors.

  Management Expectations booklets have been developed for all departments and contractors. These booklets clearly bring out various expectations of the management and the plant staff were observed to be using them as and when required.

- Reactivity control at the plant is closely monitored and stands out at the forefront of all matters.

  During simulator training the team observed that reactivity was treated as paramount and, when simulated time pressure was applied by the grid operator, reactor control and safety was still observed to be a dominating decision factor.

At the same time some other features indicate that additional efforts could result in the further improvement of safety culture:

- In certain cases the plant is referring to decision making by the regulator instead of giving reference to its own judgment and accountability for safety.

This was observed by the team during discussions on topics like acceptability of certain practices like those in emergency planning and preparedness, improvement of fire system in cable spread room, implementation of some modifications and updating of safety analysis report.

- Over reliance on bunker system in safety perception.

  To enhance safety system redundancy and diversity a bunker system (GNS) was installed in the plant in 1990. During discussion on various safety aspects like level of safety system redundancy, common cause failure, cable fire hazard etc. the team observed a perception of over reliance on the existence of this 'bunker' building in the minds of plant staff who seem to view this system as 'cure all'. Such perception could cause an obstacle in the thinking process regarding possibility of improvements in related safety systems in other parts of the plant.

- Deficient industrial safety practices.

  During their field visits the team observed a number of conditions which could lead to industrial safety hazards. These include electrical risks, insufficient lighting, tripping and bumping hazards and absence of indications and markings. This indicates inadequate plant attention which is also reflected in an insufficient value of WANO performance indicators in this area for the plant.

- Learning is not facilitated through the corrective action process as well as it could be.

  No effectiveness review process is implemented as part of the root cause analysis corrective action plans. Also, no tools as check sheets, forms, question banks, or others, are utilized to assist the carrying out of corrective action effectiveness reviews.

1.5. INDUSTRIAL SAFETY PROGRAMME

At the plant not all industrial safety related hazards and risks to workers' safety and health are identified and eliminated on an ongoing basis. The team has a suggestion in respect of industrial safety.

DETAILED MANAGEMENT, ORGANIZATION AND ADMINISTRATION FINDINGS

1.2. MANAGEMENT ACTIVITIES

1.2(a) Good practice: Use of competency grades to measure safety culture and reduce errors due to human behavior

- The plant has developed a set of competency grades to measure safety culture and reduce errors due to human behavior. The competency grades are used to measure the maturity of a team (or an individual) with regard to the use of each of the eight Human Performance tools:
  - Self management tasks: Situational awareness, Self control & organisation,
  - Management tasks: Pre-job briefing, Post-job debriefing, External verification and Observation,
  - Communication & decision tasks: Effective communication, Careful decision making,
  - Work & procedure tasks: Smart use of procedures.

- Every team member was graded for the first time in 2009 following a self assessment exercise carried out by the team leader, his manager and the Human Performance coach. The results of this exercise serve as one of several input sources for the self assessment of all the operational teams. In 2010 this grading is being performed for the second time in order to identify progress and to assist team leaders in proposing concrete personal development plans.

- The above set of competency grades is used to evaluate contractors during their mandatory 4-day training in Nuclear Safety. In 2009, during outages, contractors were evaluated in the field using the same set of competency grades. The results of this evaluation are integrated into the contractor evaluation system.

The comparison of the 2009 and 2010 results clearly reveals an increase in the maturity of teams with regard to the use of human performance tools.

1.5. INDUSTRIAL SAFETY PROGRAMME

1.5(1) Issue: Not all industrial safety related hazards and risks to workers' safety and health are identified and eliminated on an ongoing basis.

The industrial safety accident frequency rate for Doel NPP is in the last quartile of the WANO performance indicators.

The plant has implemented a strong improvement programme. However, the following deficiencies and/or facts were observed in the field indicating difficulty in observing and reporting at a low enough threshold:

Electrical risks:
- the ground wire connection to motor SR1P1605 in Turbine building was not professionally installed
- protective grounding cable not attached to 1EV5214/EV electric actuator
- protective grounding cable of air pump RM0P76 not fastened
- insufficient cable tagging on Electrical box CUB 2/518A (220V) for a motor-operated valve

Insufficient lighting:
- defective lighting above basement of room CW2P3 in the pumping station of Units 1-2
- 4 lights out of operation in room 2WVG005 above walk way to pumps in pumping station

Tripping and bumping hazards:
- Close to valve 2MW1096 in auxiliary building (room BAR 301), hole in the floor poorly covered
- 2 holes in the floor without any cover in auxiliary building in room BAR 501

Absence of indications or markings:
- Yellow-black protection close to valve 1EW1061A in Turbine Building has fallen off.
- Pipes at 2 m height close to valve 1CO802B not marked yellow-black
- Stairs with some broken steps not marked yellow/black (Location : Turbine floor Pillar E1 at level 21.5)
- No indications and markings on the floor for emergency exit in all areas, except markings on the floor in the reactor building (safety signage above exit doors is present in all areas).
- Table for storage of equipment in turbine hall (top floor near Pillar B1) has no weight limit.
- Storage area has no sign for weight limits (Location: Turbine floor Pillar B1 at top floor)

Incorrect human behavior or non-compliance with requirements:
- Whilst carrying out a plant tour, the field operator entered one hearing protection area without hearing protection and was prompted on another occasion

- Scaffolding around MW2R2 tank (interior coating repair) : platform not properly installed (loose elements). There may be some danger of workers falling.

Without timely identification and elimination of industrial safety health and hazards, it is not possible to prevent worker injury.

Suggestion: The plant should consider improving the identification of industrial safety related hazards and risks and taking necessary measures to eliminate them.

Basis:

ILO-OSH 2001

3.10 Hazards and risks to workers' safety and health should be identified and assessed on an ongoing basis. Preventive and protective measures should be implemented in the following order of priority:
(a) eliminate the hazard/risk;
(b) control the hazard/risk at source, through the use of engineering controls or organizational measures

Safety and health in construction, ILO code of conduct

2.5.4. In accordance with national legislation, workers should:
(b) take reasonable care for their own safety and health and that of other persons who may be affected by their acts or omissions at work;
(c) use and take care of personal protective equipment, protective clothing and facilities placed at their disposal and not misuse anything provided for their own protection or the protection of others;
(e) comply with the prescribed safety and health measures;

3.7.1. Where natural lighting is not adequate to ensure safe working conditions, adequate and suitable lighting, including portable lighting where appropriate, should be provided at every workplace and any other place on the construction site where a worker may have to pass.

15.1.5. All parts of electrical installations should be so … maintained as to prevent danger of electric shock.

2. TRAINING AND QUALIFICATIONS

2.1. TRAINING POLICY AND ORGANIZATION

The training organization is well structured. The Competence and Training Manager (CTM) coordinates all actions related to training and competence at the plant, in accordance with Electrabel Corporate and Electrabel Generation guidelines. The roles and responsibilities of the CTM and the Training Consultants (staff from other departments of the plant) are clearly defined. The team considers the functioning of the training organization to be a good performance.

2.2. TRAINING FACILITIES, EQUIPMENT AND MATERIAL

Sufficient guidance for conducting On the Job Training (OJT) is not always available at the plant. The team suggests the development of teaching material to formalize OJT.

2.3. QUALITY OF THE TRAINING PROGRAMME

At the plant, the systematic approach to training (SAT) is effectively applied. A Job Atlas Handbook has been developed at the Electrabel Corporate level. The Job Atlas lists all of the functions within Electrabel Business Unit Generation, the corresponding competencies and skills required. As a result, every new employee follows an initial training program that is aligned with their job description. The team considers this a good performance.

2.4. TRAINING PROGRAMMES FOR CONTROL ROOM OPERATORS AND SHIFT SUPERVISORS

In order to enhance consistency in the behavior of teams, many observations are carried out on the simulator, not only by managers, but also by members of the shift team, and shift supervisors from other teams. The team considers this a good performance.

The operator training programs, both initial and refresher, are implemented in collaboration with the human performance instructor so that the behavior of team members is further improved. During outages, these instructors go into the field to observe and coach plant personnel, thereby reinforcing management expectations. The team considers this a good performance.

There is only oral assessment for operation personnel to get their licenses, the team encourages the plant to use written and simulator examinations as an opportunity to assess the performance of licensed personnel.

2.10. GENERAL EMPLOYEE TRAINING

To reinforce compliance with expectations and human performance, a field simulator has been developed. It is widely integrated into initial and continuous training of all plant personnel and contractors. The team considers this a good performance.

The defense-in-depth principle as a strategy for nuclear safety is integrated into all training courses and programs. This practice ensures a good balance in training between technical, procedural and behavioral subjects, and raises overall awareness and understanding of nuclear safety among all personnel. It also provides guidance to focus management attention, and makes people more aware of their role in preventing or mitigating events by using human performance tools. The team considers this a good practice.

DETAILED TRAINING AND QUALIFICATION FINDINGS

2.2. TRAINING FACILITIES, EQUIPMENT AND MATERIAL

2.2(1) Issue: Sufficient guidance for conducting On the Job Training is not always available at the plant

- The plant has 163 catalog items of On-the-Job Training (OJT). Each OJT is implemented under the guidance of a single specification sheet and a general procedure. For 70% of OJT, there are no other materials such as qualification guidelines, scenarios, etc, to assist in delivering OJT;
- OJT is coached by experienced but non certified plant personnel and training consultants;
- 2 specific OJT trainers designated for D1&2 operation crews (6 for all crews) will be certified as OJT trainers in the summer of 2010. However, their OJT-specific instruction skills training will be limited to just one day. In view of large number of staff to be trained, number of trainers designated for OJT and duration of their training is judged to be inadequate.

Without formalized OJT, deficiencies in the quality of training could exist, leading to performance problems at the plant. This is very important for the plant at this stage, as it has recently been augmenting its staff at a rapid rate. More than 300 employees have been recruited in the past four years, and their induction training is currently in progress.

Suggestion: The plant should consider developing and implementing teaching material for OJT that can assist OJT trainers and provide benefit to formalized training.

Basis:

NS-G-2.8

5.2 Formal on the job training provides hands-on experience and allows the trainee to become familiar with plant routines. However, on the job training does not simply mean working in a job and/or position under the supervision of a qualified individual; it also involves the use of training objectives, qualification guidelines and trainee assessment. This training should be conducted and evaluated in the working environment by qualified, designated individuals.

2.10. GENERAL EMPLOYEE TRAINING

2.10(a) Good practice: The defense-in-depth principle as a strategy for nuclear safety is integrated into all training courses and programs.

This strategy is based on the three types of barriers: design, methods and behavior.

At the plant, when a training program is developed or updated, this principle of defense in depth is highlighted, and the training objective focuses on the relevant barriers. This is done for all types of training (initial and continuous training programs for Electrabel staff as well as for contractors) and all functions (e.g. work planners in maintenance, and licensed and non-licensed operators). The idea is supported by visual aids such as posters, documentation and an introduction in all training material.

At each session in classroom training, e.g. .human performance training for all personnel, the defense-in-depth principle is emphasized in analysis of behavior-and knowledge-based errors. All three barriers are analyzed as one of the most important parts of full-scope simulator and field simulator sessions.

To further enhance the effectiveness of the training, and to reinforce management expectations, management carries out observations in the field. The three barriers are re-evaluated on the basis of events to identify possible improvements.

This practice ensures a good balance in training between technical, procedural and behavioral subjects, and raises overall awareness and understanding of nuclear safety among all personnel. It also provides guidance to focus management attention, and makes people more aware of their role in preventing or mitigating events by using human performance tools.

3. OPERATIONS

3.1. ORGANIZATION AND FUNCTIONS

The management expectations within the operations department are clearly communicated via several different methods from signage around the plant, individually issued handbooks and text within operational procedures. The interviews were conducted at all levels in the organisation and confirmed that these were understood.

The operations department, along with others, are very actively using self assessment to improve their performance and set their objectives for the following year. The process they use is called "yellow sticky exercise" and involves the whole shift team. The team reviews event reports and task observations generally related to that shift and identifies common causes and areas for improvement. This exercise is supported by senior members of the operations management team and a human performance coach. This area has been taken forward as a good practice in Operating Experience.

The operations department currently doesn't use the probabilistic safety assessment as a tool to help quantify the stations current and projected operational risk during periods of planned and emergent maintenance. The team has made a recommendation concerning the development of PSA in the Technical Support area.

The operations department uses a transverse theme approach to help with improvement in various areas. Each improvement area is assigned a champion and by using this approach they are able to capitalise on resources and experiences from the other two Doel units. This also provides a common standard for all four Doel units. The operations department interfaces with other key groups well via a number of structured meetings providing the appropriate level of operational focus. The team recognizes this as good performance.

3.2. OPERATIONS FACILITIES AND OPERATOR AIDS

The team noted the good standard of material condition on the majority of plant systems and would encourage the plant to continue their efforts to eliminate any small concerns noted. The team also noted the high quality of procedures available and the effectiveness of the updating process.

Procedural guidance is not currently in place to ensure the control room environment remains habitable by Operators with respect to oxygen content following an accident. The team developed a recommendation for this purpose.

3.4. CONDUCT OF OPERATIONS

The team observed good performance in this area. The control room environment is quiet and organized. Operators were observed to be attentive to their indications and responsive to alarms. In the area of reactivity management, safe controls were observed in the control room and the plant has an effective mechanism for reviewing reactivity concerns and driving them to completion. Operators are observed to have a low tolerance for equipment deficiencies. A few minor unreported deficiencies were noted by the team, demonstrating that some room for improvement remains. Surveillance tests are well controlled and good performance is noted in the plant's program for trending the results. Operations management is supportive of and involved in crew decision making.

The team noted that in the past 12 months the plant has experienced a number of plant alignment events and during the evaluation suffered a loss of oil from the turbine oil system due to a valve being left in the incorrect configuration. The OSART team encourages the plant to investigate each misalignment event with the same rigour independent of the actual significance of the alignment event.

3.5. WORK AUTHORIZATIONS

Procedures and programs for controlling modifications and work on plant equipment are rigorously controlled. A new planning mechanism has recently been implemented that the team recognizes as a feature that will provide future good performance. The independent verification policy in the Operations department, known as QC1, is unique and effective in that it is modelled after the Quality Control processes from manufacturing. This practice is applied to equipment operations and documentation. The team recognizes this as good performance.

Temporary configurations are well communicated and controlled. The team noted that temporary configurations are reviewed against the plant's licensing basis shortly after implementation. The team encourages the plant to complete this review prior to installation.

3.6. FIRE PREVENTION AND PROTECTION PROGRAMME

The fixed fire protection systems throughout the plant are in good working order and a well defined inspection program exists to ensure the continued operability of the equipment. The overall material condition of the fire protection system was observed by the team to be a good performance.

In some areas of the electrical building, cable separation schemes and compartmentalization were seen to be inadequate. The team developed a suggestion for this purpose.

The fixed protection systems are supplemented by mobile equipment that the plant has effectively incorporated into their strategies. Of particular merit, are the foam capabilities that are available. Locally installed foam supplies and applicators were noted in many key areas of the plant. Additionally the mobile units include a large foam monitor and supply tank. This equipment will serve the site well in the event of a turbine oil or large oil filled transformer fire. The team considers this to be a good performance.

The plant employs a key performance indicator to monitor its performance relative to combustible loading in the plant. This strategy has been effective in reducing the combustible loading to as near zero as achievable and the plant continues to strive for improvement. The plant is encouraged to eliminate the use of untreated wood inside the power unit and evaluate its method of collecting non-oily trash. It should be noted the site has begun the acquisition of metal pallets to eliminate the use of wooden pallets.

A well trained fire brigade is in place and exercises are rigorous events that effectively challenge most aspects of the program. Intervention plans are in place, that provide sufficient information for fire fighting in each space. The site is encouraged to consider adding to the intervention plans, the equipment in each space that is important to nuclear safety to allow fire commanders to recognize what equipment to protect.

The site employs well qualified contract instructors who evaluate drill performance, facilitate the de-briefing and provide on the spot coaching and immediate re-training as needed. The team observes this to be a good performance.

3.7. MANAGEMENT OF ACCIDENT CONDITIONS

Plant procedures are well established and current with the Westinghouse Owners Group (WOG) recommendations. Adequate information is provided in Emergency Operating Procedures (EOP) and beyond design basis procedures to support analysis of accidents. The site has developed a custom EOP for monitoring of support items under accident conditions. The team recognizes this as a good practice.

Shift staffing is adequate for immediate actions and a well established staffing plan is in place for incidents which may impact both units. Training of the staff effectively utilizes the simulator and coaching is effective and constructive. Operations management is observed as involved in the training and feedback mechanisms. The plant has developed an assist mechanism to monitor and alert the operator on the status of EOP continuous actions. The team recognizes this as a good practice.

DETAILED OPERATIONS FINDINGS

3.2 OPERATIONS FACILITIES AND OPERATOR AIDS

3.2(1) Issue: Procedural guidance is not currently in place to ensure the control room environment remains habitable by operators with respect to oxygen content following an accident.

The site has pre-staged equipment that would satisfy the monitoring and compensatory actions. It is currently available and well maintained, however the existing Emergency Operating Procedures do not invoke its use.

- No procedural guidance exists for monitoring of Control Room oxygen content
- No procedural guidance exists for compensatory actions such as periodic alignment of the intake or donning breathing apparatus
- No studies have been performed to determine the habitability of the Control Room relative to oxygen content under accident conditions

The Doel 1&2 Control Room is completely isolated from makeup air supply under radiological accident conditions and during toxic gas incidents. The isolation of the fresh air supply creates a potential concern for the oxygen content of the air in the control room. Continued habitability of the control room remains necessary to achieve Safe Shutdown conditions. The GNS building is not equipped with a filtered air supply.

Without specific analysis or proceduralized actions to monitor and control the oxygen content of the Control Room, the ability of the operations crew to achieve and maintain safe shutdown conditions could be affected.

Recommendation: The plant should analyze the behavior of control room oxygen content under accident conditions and staffing levels and determine what procedural controls are necessary to ensure habitability for the duration of the postulated accident.

Basis:

NS-R-2

5.11 “Operating procedures shall be developed which apply comprehensively for … emergency conditions.” “The level of detail for a particular procedure shall be appropriate for the purpose of that procedure. The guidance provided shall be clear, concise, and as far a possible verified and validated.”

NS-G-2.2

8.9 “For event based procedures, the decisions and measures to respond to accidents should be made on the basis of the state of the plant in relation to predefined events, which are considered in the design and safety analysis report.”

NS-G-2.14

6.1. The equipment used by operations staff should be adequate to support the safe and reliable operation of the plant in all operating conditions and should be well maintained.

3.6. FIRE PREVENTION AND PROTECTION PROGRAMME

3.6(1) Issue: In some areas of the electrical building, cable separation schemes are inadequate. Within the cable spreading vault, some cable trays are filled to the point of preventing utilization of a fixed extinguishment system. Compartmentalization and fire control are credited instead.

The team noted that the site has taken note of this issue and placed supplemental manual fire fighting equipment and the sprinkler system has been upgraded. The consequence of a potential fire is mitigated by the addition of the Bunker System. If a loss of plant control occurs due to a fire in cable spreading vault, a safe shutdown is expected to be accomplished from the GNS Bunker Control Room, for which this building is designed.

Specifics of the cable separation deficiencies are as follows:

- In the cable spreading vault, and in the DC electrical equipment rooms on each end, some cables are placed outside of cable trays or are routed close to power supplies of a different safety bus. This practice potentially compromises cable separation and fire protection schemes.

  - GEH516 - cable crossing different polarities
  - Numerous examples of cables routed outside of trays when rounding a corner.
  - Supports have been added to the side of the trays to support additional cables but separation barriers are not in place
  - Cables of different polarities are run vertically, directly against the side of the cable tray without the addition of barriers

- The plant has embarked on an appropriate effort to eliminate the asbestos bearing separation boards in their cable tray system. In some areas the new material has been installed with less than optimum workmanship. Gaps have been observed between boards and in a few cases the boards have fallen.

  - GEH516 - plate loose under cable tray
  - GEH516 - plate loose under cable tray
  - GEH516 larger gap between boards than expected

Cable trays in some areas of the cable spreading vault are so full as to prevent utilizing a fixed fire extinguishment (as opposed to suppression) system due to the inability to water spray to penetrate into the tray. The site credits manual fire attack and a sprinkler system that prevents flashover conditions to round out a compartmentalization method of mitigation.

- Several safety related cable trays in the cable spreading vault are filled to capacity which results in multiple polarities or safety buses being affected.

Without proper cable separation and adequate compartmentalization, the consequence of an electrical fire is increased. Fire in the cable spreading room has the potential to require a

Remote Safe Shutdown be performed from the GNS on both Units 1 &2, for which this building has been designed.

Suggestion: Areas where cables are run outside of cable trays or without proper separation should be considered for remedies such as the addition of separation material or the rerouting of the cable. In the cases where cable trays are so full as to prevent a fixed extinguishment system from being effective, the plant should consider analyzing the effectiveness of their compartmentalization strategy and prepare appropriate corrective actions as necessary.

Basis:

NS-G-2.1

2.3. safety systems are adequately protected to ensure that the consequences of a single fire will not prevent those systems from performing their required function, account being taken of the effects of a single failure.

7.2. The inspection, maintenance and testing programme should cover the following

fire protection measures:

- passive fire rated compartment barriers and structural components of buildings, including the seals of barrier penetrations;
- locally applied separating elements such as fire retardant coatings and cable wraps;

NS-G-1.7

IV.2. Various design approaches have been taken to limit the significant impact of cable fires. Among these approaches are: protecting electrical circuits against overload and short circuit conditions; limiting the total inventory of combustible material in cable installations; reducing the relative combustibility of cable insulation; providing fire protection to limit fire propagation; and providing separation between cables from redundant divisions of safety systems, and between power supply cables and control cables.

IV.3. Controls should be imposed on the quantities of polymer insulated cables installed on cable trays and within cable routes. These controls are necessary to prevent the fire load exceeding the rated resistance of compartment fire barriers and to minimize the rate of spread of fire along cable trays. The controls may include limits on the numbers and sizes of cable trays and/or the loading of insulation upon them, and should correspond to the combustion characteristics of the cables used.

IV.5. In some circumstances, specific passive protection measures may be necessary to protect electrical cables from fire. Such measures include:

- Cable wraps to provide segregation from other fire loads and from other systems,

IV.9. The potential impact of cable fires can be reduced by providing suitable separation, either by the fire containment approach or by the fire influence approach.

3.7 MANAGEMENT OF ACCIDENT CONDITIONS

3.7(a) Good Practice: Computerised method for monitoring Emergency Operating Procedure (EOP) continuous actions.

The plant has a computerised monitoring system for tracking the status of continuous actions in emergency conditions.

Most Emergency Response Guidelines (ERG's) have continuous and permanent actions which the operators have to take care of. Entering a new ERG procedure, the operator monitors the fold out page (with all applicable continuous actions). The operator has to act immediately performing the actions written in the fold out page

The monitoring of these actions at the plant is carried out by a computerised monitoring system.

The benefit of this "active" status light/screen is that the operator sees more rapidly when he has to take action. When the screen is passive he has to check every parameter on the fold out page. With the "active" screen he only reacts when he sees a red light / sign.

This is the same method as the status light (red/orange/yellow/green) in the status trees of the critical safety functions.

3.7(b) Good Practice: Custom Emergency Operating Procedure (EOP) for monitoring support functions.

The plant staff has created an EOP in addition to those specified in the standard Westinghouse Owners Group (WOG) network. During accident conditions the control staff responds to the event utilizing a standard matrix of procedures. The processing of these procedures fully occupies the control room staff. In order to reduce this burden, and prevent a low level problem from escalating to a large issue, the plant supplements the monitoring function outside the control room through the use of a custom EOP known as ES 0.5.

The procedure is utilized by an extra operator located outside the Control Room. This operator assists the crew by monitoring electrical power sources, water supply, ventilation, radiological release paths, containment isolation and many other items.

This prevention based strategy will detect and mitigate a concern early in the event and eases the burden on the Control Room Crew.

4. MAINTENANCE

4.1. ORGANIZATION AND FUNCTIONS

Management expectations for maintenance were revised in 2008. They include a strong focus on human performance tools during daily work processes (pre-job briefing, situation awareness, procedure adherence, external verification, post-job debriefing).

A biannual training program on the field simulator for all individuals ensures the integration of management expectations into daily maintenance work. This is considered a good performance.

The team recognized a good practice in the area of contractor management where an assessment of contractors' competency in nuclear safety culture is performed.

The team recognized a good practice in the certification program for maintenance work planners who have a key role in the quality of execution of maintenance activities. An intensive training program which lasts 18 months has been developed for this particular function, leading to a formal accreditation.

4.2. MAINTENANCE FACILITIES AND EQUIPMENT

The team recognizes a good performance in the tracking program for calibrated measurement tools. The traceability of measurement and test equipment used for an activity is ensured by recording the ID of measurement and test equipment on the work permit. This is then logged in the database, so that it is easy to trace which work has been performed with a given measurement tool.

4.3. MAINTENANCE PROGRAMMES

The team recognized weaknesses in the management tool for maintenance backlogs and in the timely completion of maintenance work. The team has made a suggestion in this respect.

4.5. CONDUCT OF MAINTENANCE WORK

During walk downs the team observed a number of defect tags still present in the installation despite the fact that the maintenance work was finished. In addition sediments from past leakages were still present on pipes in two cases. The team encourages the plant to enhance the rigor in the performance of assigned maintenance tasks.

The plant has integrated its FME (foreign material exclusion) policy into its daily work methods. Special FME tools are made available in the installations through FME carts, which contain FME equipment. This was recognized as a good performance by the team.

4.6. MATERIAL CONDITIONS

Although the overall plant material condition is good, the team found examples where consistent high standards were not maintained due to lack of attention to detail by maintenance personnel. The team suggested that the plant should consider eliminating inadequate conditions existing in certain plant by paying attention to details and improving maintenance workmanship.

The plant has developed an effective leak reduction program which started in 2009. 93% of registered leaks, dated from before end of 2008, had been dealt with by the end of 2009 already. In addition, the plant is making a considerable effort to control leaks, and the program is continuing with the aim of preventing further leaks. This was recognized as a good performance.

4.7. WORK CONTROL

In order to reduce the number of accidents during maintenance activities, a site-wide approach with regard to at-risk worksites was introduced at the plant in 2008. Several improvements have been implemented, including enhanced risk analysis (reinforced in pre-job briefings) and daily checks of the worksite, which are logged on a worksite information panel. This was recognized as a good performance.

DETAILED MAINTENANCE FINDINGS

4.1. ORGANIZATION AND FUNCTIONS

4.1(a) Good Practice: Assessment of contractors' competency in nuclear safety culture during outages

The plant has established a coaching and training program in nuclear safety culture for all contractors.

A 4-day training course was developed for this purpose, involving general training in nuclear safety culture as well as more specific training for contractors in the management expectations of the plant. This is comparable with the contractor safety and quality programs that exist in other countries.

In addition, a coaching program is provided in which the instructor coaches the contractors in the field during outages.

To ensure that the training program is about more than just attaining a certificate, the contractors receive an assessment of their competency in nuclear safety culture after the field coaching program, to underline the importance of continuous improvement, which is a key characteristic of nuclear safety culture.

A special edition of the management expectations designed for contractors has been produced for this purpose. The booklet of management expectations is the common denominator throughout the training. The contractors receive a copy of this booklet during training.

There is very strong focus on Human Performance during the training. The head of the 4-day training program is also the HU coach from the plant Maintenance, which ensures that contractors receive identical HU training to plant staff.
All contractors who work in technical installations at the plant, must obtain a certificate in nuclear safety culture. This certificate is issued after a theoretical and practical evaluation of contractors' competency in Nuclear Safety Culture.

Up to now, 3,938 contractors have been certified.

The training programs are given in Dutch, German, English and French.

The instructors are trained and have been qualified by the plant.

4.1(b) Good Practice: Certification program for maintenance work planner

The work planner has a key role in the Maintenance department at the plant.
An intensive training program has been developed for this particular function, leading to a formal accreditation. The training program lasts 18 months and consists of 4 modules. During the training program, there are 3 examinations (after the first 3 modules), a on the job training period, and a final examination with certification after the fourth module, where line management is present. This program entails classroom training modules, self-study and formalized on-the-job training.

In this programme equal weight is given to the 3 barriers of the defense in depth model (design, work practices and behavior).
The head of Care Nuclear Safety is a member of the evaluation committee, to determine if the work planner has sufficient knowledge in that particular area.

Maintenance has drawn up an accreditation program for maintenance work planner with the same depth as that of a reactor operator.

4.3. MAINTENANCE PROGRAMMES

4.3(1) Issue: There are weaknesses in the maintenance backlog management tool and the methodology for ensuring timely completion of maintenance works.

A significant programme to reduce Maintenance backlog has been implemented by the plant, however the team observed the following:

– Out of the 8,000 work orders presently under execution at the plant, around 1,000 have exceeded their assigned date of completion. Some of these overdue work orders are more than three years old. Though an improvement over recent years, this is still a large number. 30% of work orders which have exceeded their completion date are in the highest plant priority of 'high focus', and 87 of these work orders concern safety related systems (some of these covering different phases of the same equipment).

– In view of the large maintenance work backlog and the inability of the existing SAP system to identify this efficiently, a new backlog management tool was introduced at the plant in January 2009. The following weaknesses were observed in this new system.
  - Within the overall guidance document for work management, the methodology and responsibility for postponing overdue work is not specified.
  - Once a revised date is assigned for a work order, it is automatically removed from the backlog list, and the vital data identifying it as a work order exceeding its initial due date, and indicating the number of times it had been postponed, is lost, and is not captured by the plant.
  - New due dates are not assigned to all backlog work orders.
  - During a field visit, the team noticed a defect tag on a valve in the component cooling system (tag 25173) dating back to 2007. Work on this defect was planned to be carried out during the unit 1 steam generator replacement. However, when starting work preparation in 2009, Operations realized that the work can only be undertaken during shutdown of both units 1 and 2, thus resulting in the work order moving to the backlog list. As of now, new dates for this work have not been assigned, and no analysis has been performed regarding the effect on system availability and reliability of such a long delay in rectifying the deficiency.

Weaknesses in timely completion of maintenance work can affect the availability and operability of plant equipment and systems.

Suggestion: Consideration should be given to improving the backlog management tool and methodology so as to ensure timely completion of maintenance work orders at the plant.

Basis:
NS-G-2.6,
5.14 A comprehensive work planning and control system applying the defense in depth principle should be implemented so that work activities can be properly authorized, scheduled and carried out by either plant personnel or contractors, in accordance with appropriate procedures, and can be completed in a timely manner. The work planning system should maintain high availability and reliability of important plant SSCs.

4.6. MATERIAL CONDITION

4.6(1) Issue: In certain plant areas inadequate conditions exist due to lack of attention and insufficient maintenance workmanship.

Although the overall plant material condition is good, the team found examples where improvements are still needed to maintain consistent high standards, indicating a certain lack of attention to detail in the following areas:

Some cables are not properly fixed to cable trays, due to the fact that some cable ties are missing or are not in good condition:

- Doel 2, turbine hall, 4th level: several cable ties are broken, resulting in a cable not being properly attached to the cable tray.
- Doel 2, turbine hall, 2nd level, train B: the cable to the positioner of valve 2CO826B was not properly attached to the cable tray due to two broken cable ties.
- Doel 1, turbine hall, cable tray near condenser, wall pillar C1-E1: cables loose on the tray.
- Doel 2, turbine hall, train B: cable hanging beside the cable tray.

Deficiencies regarding pipe hangers and supports:

- Sliding pipe support near OCC85 does not fulfil its function.
- A stainless steel pipe near 2SI26 and 2SI418 is supported in four places by a carbon steel pipe hanger.
- In GNH320, behind 2SI107, several stainless steel pipes are in direct contact with the carbon steel clamps of the pipe hangers.

Some flanges are not professionally installed:

- Flange of flushing water pipe (DW) of CV2P2A has two washers missing
- One nut of flange near charging pump 1CV-0072 fitted upside down
- Two washers missing on a flange of the emergency diesel cooling system EDK1Y5

Deficient material conditions, if left unattended, could lead to deterioration of the equipment and systems at the plant, resulting in their unreliability.

Suggestion: The plant should consider eliminating inadequate conditions existing in certain plant areas due to lack of attention and insufficient maintenance workmanship.

Basis:

NS-G-2.6
9.18 Other items that should be subject to surveillance are those that , if they were to fail, would be likely to give rise to or contribute to unsafe conditions or accident condition.
Such items include:

- high energy piping and associated piping restraints
- structural supports (stack stay ways wires, pipe supports)

10.17. A visual examination should be made to yield information on the general condition of the part, component or surface to be examined, including such conditions as the presence of scratches, wear, cracks, corrosion or erosion on the surface, or evidence of leaking…Any visual examination that requires a clean surface or decontamination for the proper interpretation of results should be preceded by appropriate cleaning processes.

NS-G-2.14
4.36. Factors that should typically be noted by shift personnel include:
—Deterioration in material conditions of any kind, corrosion, leakage from components, accumulation of boric acid, excessive vibration, unfamiliar noise, inadequate labelling, foreign bodies and deficiencies necessitating maintenance or other action;

INSAG-12
116. Principle: Operational excellence is achieved in present and future nuclear power plant operations by: augmenting safety culture and defence in depth; improving human performance; maintaining excellent material condition and equipment performance; using self-assessments and peer reviews; exchanging operating experience and other information around the world; increasing application of PSAs; and extending the implementation of severe accident management.

5. TECHNICAL SUPPORT

5.1. ORGANIZATION AND FUNCTIONS

Responsibilities and authorities are clearly allocated from the site manager to the engineering department, and from the engineering department to different sections. The responsibilities and allocations of authority are clearly documented in procedures. However, the team found that the description in the SAR (section 13.1.2.2) of the mission, organization and main activities of the engineering department is to some extent different from the description in the department procedure (REF/E/01/ *Organisatie department Engineering*). The team has made a suggestion on the updating of the SAR that relates to this and other contributing facts.

A plant specific Probabilistic Safety Analysis (PSA) is used at the site. However, the plant currently has only a limited model for shutdown modes, and no fire PSA. In parallel to updating the currently used level 1 model developed in 2000 the plant is also developing a level 2 analysis. The team has made a recommendation in this area.

The third PSR, which is still ongoing, started in 2001, and is scheduled to be finalized by 31 December 2011. The team considers that the long time required to perform and finalize PSRs is in accordance neither with the IAEA guides nor best international practice. The team has made a suggestion in this area.

The long execution time of the PSRs implies that, for example, the external hazards chapter in the SAR (*Chapter 2 – Kenmerken van de vestigingsplaats*) has not been updated since 1992. The team has made a suggestion on the updating of the SAR that relates to this and other contributing facts.

The team found that the backlog of plant modifications started to increase in 2002 and has been at a high but stable level since 2007. At the beginning of 2010, around 600 modifications were found not to be finally closed out. One of the contributing factors to the increased backlog was an underestimation of the increase in work-load resulting from commitments made by the plant made in order to enhance safety and operations. Another factor was a shift from classifying modifications as “small modifications” (KW) to “Non-important Modifications” (NBW), the latter requiring more work. The plant has set a target of reducing the backlog to zero by the end of 2012. The team encourages the plant to continue this effort.

Goals and objectives are used at site and department level. Key Performance Indicators (KPI) are used at site level (tier 1 and 2), but have recently been introduced in the engineering department (tier 3). Due to the recent introduction of KPIs, the threshold levels are not properly adjusted and the indicators are of limited value. The team encourages the plant to set properly adjusted threshold values in all departments. The good performance of the fuel department could serve as a good example in this area.

Overtime is only registered for about 50% of the staff of the Engineering department, management included. The team encourages the plant to increase the number of personnel reporting overtime. This will facilitate staff sizing and avoid overloading personnel in responsible positions.

In the engineering department, and on major projects, e.g. PSR projects, senior and junior engineers work in pairs, thus facilitating the transfer of knowledge. The team considers this a good practice.

The plant has implemented a comprehensive “Observation in the field program” that not only involves managers but also senior engineers. The team considers this a good performance.

The fuel department uses a training scheme that includes: theory, practise on dummy components, observations in the field, and on-the-job training. The training is supported by systematic follow-up and use of report forms for each step. The team considers this a good performance.

The plant uses independent assessment to verify the effectiveness of important processes. However, the team encourages the plant to broaden the scope of independent assessment in order to determine the adequacy of work performance and leadership in general, evaluate the organization’s safety culture, and identify other opportunities for improvements.

5.2. SURVEILLANCE PROGRAMME

The plant has established and implemented a comprehensive and adequately documented surveillance program. However, the team found that anchor bolts for components with safety functions are not fully included in the program. Based on experience from other plants that have encountered problems with anchor bolts, the team encourages the plant to include these and other fastening elements in the surveillance program.

Corrosion monitoring of water filled fire extinguishing pipes has been transferred from the fire fighting personnel to the engineering department. The team considers this a proactive measure, because the monitoring and surveillance of corrosion processes requires specialist competence.

The team observed that the staff started trouble shooting equipment on the spot when a test failed, instead of applying the STAR concept (Stop, Think, Act, Review). In order to avoid plant disturbances or more serious deterioration of components, the team encourages the plant to enforce more rigorous use of the STAR concept.

5.3. PLANT MODIFICATION SYSTEM

The team reviewed a list of plant modifications starting from 2005 and can conclude that several of these modifications will enhance safety. The team acknowledges this programme as a good performance.

However, the team noted weaknesses associated with analyses of internal hazards such as fire and missiles in some rooms with safety-related pumps. Electrically driven auxiliary feed-water pumps are located in the same room with no segregation between the trains. The same applies to the safety injection pumps and charging pumps. The team also noted that measures taken to prevent internal flooding in the rooms where the auxiliary pumps are located were obstructed by measures to prevent intrusion into the rooms from outside the building. The team encourages the plant to address in more details common cause failure due to fire or missiles, since pumps that belong to different trains are not physically segregated.

The team found that the plant has an adequate system for categorizing the safety significance of modifications. However, it is not easy to retrieve a list of those modifications that are primarily implemented in order to enhance the safe operation of the plant. The team encourages the plant to improve the system so that the scope of modifications implemented to improve safety can be easily reviewed.

5.5. HANDLING OF FUEL AND CORE COMPONENTS

The fuel department has compiled a pocket size book that is easy to use and provides a clear overview of all tools, machinery and installations used for handling fuel and core components. The team considers this a good practice.

5.6. COMPUTER BASED SYSTEMS IMPORTANT TO SAFETY

The team found that cable arrangements under removable floor sections were disorderly, and the antistatic ground connections on several of the removable floor sections were disconnected. The team encourages the plant to correct these deficiencies.

The team found that the plant process computer is not adequately protected from intrusion via workstations connected to the plant local area network (outside the main control room and computer room). The team encourages the plant to improve the security system in order to prevent unauthorized access from the plant area network.

DETAILED TECHNICAL SUPPORT FINDINGS

5.1 ORGANIZATION AND FUNCTIONS

5.1(a) Good Practice: In the plant engineering department and in major projects, senior and junior engineers work in pairs in a planned and structured way, thus facilitating the transfer of knowledge.

Many new young engineers have recently been recruited in order to take on future workload when older staff retire and/or when the workload increases because of new challenges like long term operation projects, ten-yearly periodic safety analyses, adaptation to new regulations, etc. These undertakings can be used to transfer knowledge from more experienced employees to a younger generation. The transfer of knowledge is crucial from a long-time perspective in order to prevent existing knowledge and experience from being lost in the organization.

Besides the standard training programmes, based on the Systematic Approach to Training (SAT) concept in the engineering department, teams composed of a senior engineer and a junior engineer work in pairs to facilitate this transfer of knowledge. This systematic approach for the transfer of knowledge improves and facilitates the build-up of the required competency and skills in a natural way.

5.1(1) Issue: The plant uses Probabilistic Safety Analyses (PSA) to a limited extent for assessments and risk evaluations.

- The currently used model for level 1 analysis has not been updated since 2000. A new model is, however, under development.
- The plant currently has only a limited model for shutdown modes and has no fire PSA.
- PSA is used to a limited extent for operational decision-making as well as for risk evaluation for preventive maintenance activities and the planning of outages. PSA is not used to optimize the Operational Limits and Conditions (OLC).
- The plant has no PSA level 2 analysis that enable it to identify ways in which radioactive releases from the plant can occur and estimate their magnitude and frequency. However this analysis is under development.

Without a modern and updated probabilistic safety assessment model, it is difficult to understand and enhance plant vulnerabilities, including complex situations due to equipment and/or human failures. PSA is also a useful tool for optimizing the implementation of the defence in depth concept.

Without a regularly updated PSA model, there is only a limited basis for risk-informed decision making.

Recommendation: The plant should prioritize and enhance its development and implementation of the PSA model as well as the utilization of a regularly updated model.

Basis:

INSAG-14

51. Improvements to the actual safety level of a plant are obtained either through improvements to its overall quality of operation or through upgrades of the safety requirements applicable to the plant; in this respect, particular consideration is given to the results of probabilistic safety assessments to complement, as appropriate, deterministic design rules. It is therefore worthwhile to compare the current safety requirements applicable to the plant with the safety requirements applicable to the most recent plants, in order to decide if the current safety requirements are still sufficient and acceptable.

NS-G-2.2

3.16. Consideration should be given to probabilistic safety assessment (PSA) applications in the optimization of OLCs. Probabilistic assessment methods together with operating experience may be used for justification and modification of OLCs.

NS-G-2.10

4.30. PSA is a comprehensive and structural approach to identify weaknesses in the design and operation of the plant and to evaluate and compare potential options for remedying any such weaknesses. The weaknesses (e.g. the potential for cross-links and the effects of common cause events which were often not adequately considered in older plant designs) are identified by considering the contribution to the risk from groups of postulated initiating events and human errors, and from measures of the importance of safety systems. The results of a PSA should be compared with the probabilistic safety criteria (e.g. for system reliability, core damage and releases of radioactive material) when they have been defined for the plant.

4.31. The PSA should be kept sufficiently up to date during the plant lifetime to make it useful for the decision making process.

NS-G-1.2

4.123. Probabilistic safety analysis provides a comprehensive, structured approach to identifying accident scenarios and deriving numerical estimates of risks. PSAs for nuclear power plants are normally performed at three levels as follows:

4.124. Level 1 PSA, which identifies the sequence of events that can lead to core damage, estimates the core damage frequency and provides insights into the strengths and weaknesses of the safety systems and procedures provided to prevent core damage.

4.125. Level 2 PSA, which identifies ways in which radioactive releases from the plant can occur and estimates their magnitude and frequency. This analysis provides additional insights into the relative importance of accident prevention and mitigation measures such as the use of a reactor containment.

4.126. Level 3 PSA, which estimates public health and other societal risks such as the contamination of land or food.

4.129. Where the results of the PSA indicate that changes could be made to the design or operation of the plant to reduce risk, the changes should be incorporated where reasonably achievable, taking the relative costs and benefits of any modifications into account.

5.1(2) Issue: The plant has not fully updated the Safety Analysis Report (SAR) to reflect the current status and the licensing basis of the plant.

- The description of the engineering department in the SAR is to some extent different from the description in the department procedure (REF/E/01/ *Organisatie departement Engineering*).
- The external hazard chapter (chapter 2) in the SAR has not been updated since 1992.
- External hazards are analysed in a report (*2TJHD12/4NT/3681/03*) from 1995. Some of the data in the report differs from older data in the SAR. Despite this, the decision was made not to update the SAR.
- Due to the backlog of finalization of plant modifications there are about 180 modifications that relate to 48 different updates of the SAR. The oldest of these modifications is from 1997. A proposed new text is available for 34 out of the 48, but not finally approved. An additional 8 new proposals for text updates will be available in the near future. For the remaining 6 updates, there are currently no new text proposals in the pipeline.

Without a Safety Analysis Report that is updated and reflects the current state the SAR cannot fulfil its purpose as the licensing basis of the plant.

The SAR is part of the overall justification of plant safety; it should reflect the current status and the licensing basis of the plant, and should be kept up to date accordingly. This is sometimes referred to as a 'living' SAR.

Suggestion: The plant should consider enhancing its routines for keeping the SAR updated as a 'living' document so that it reflects the current state of the plant, its organisation and site-specific hazards.

Basis:

GSR Part 4

4.64. The safety report has to document the safety assessment in sufficient scope and detail to support the conclusions reached and to provide an adequate input into independent verification and regulatory review.

4.65. The safety report is to be updated as necessary.

GS-G-4.1

2.1. The SAR represents an important communication between the operating organization and the regulatory body, and it forms an important part of the basis for licensing a nuclear power plant and an important part of the basis for the safe operation of a plant. The SAR should therefore contain accurate and sufficiently precise information on the plant and its operating conditions and should typically include information on, for example, safety requirements, the design basis, site and plant characteristics, operational limits and conditions, and safety analyses in such a way that the regulatory body will be able to evaluate independently the safety of the plant

3.25. This section should present the results of a detailed evaluation of natural and human induced hazards at the site. Where administrative measures are employed to mitigate these hazards (especially for human induced events), information should be presented on their implementation, together with the roles and responsibilities for their enforcement.

3.28. It should be demonstrated that appropriate arrangements are in place to update evaluations of site specific hazards periodically in accordance with the results of updated methods of evaluation, monitoring data and surveillance activities.

4.3. Since the SAR is part of the overall justification of plant safety, it should reflect the current state and the licensing basis of the plant and should be kept up to date accordingly (this is sometimes referred to as a 'living' SAR).

3.155. This section should provide a description of the arrangements of the operating organization and specify the functions and responsibilities of the different components within it. The organization and responsibilities of review bodies (e.g. safety committees and advisory panels) should also be described. The description of the organizational structure should demonstrate that all the management functions for the safe operation of the power plant, such as policy making functions, operating functions, supporting functions and reviewing functions, are adequately addressed.

5.1(3) Issue: The plant has not performed its last two Periodic Safety Reviews (PSR) in a timely manner.

- The team found that the plant's second Periodic Safety Review (PSR) started in 1991. Preliminary results were available as early as 1995, but the final report, containing the final results and safety improvements, was not issued until 2005.
- The third PSR started in 2001 (during a period when the second PSR was not even finalized). Preliminary results were available in 2005, the corrective actions and/or safety improvement results of the third PSR are scheduled to be finally defined and approved by the end of 2011.
- The long execution time for the second and third PSR, and the fact that sections of the SAR cannot be updated until the relevant studies within the PSR framework have been approved, have for example, prevented the updating of the chapter on external hazards in the SAR until at least 9 years after the initial start-up of this PSR.

The plant and the regulator have recognised that previous and ongoing PSRs have not been performed in a timely manner. One measure taken is that the plant is required by an updated license condition to submit the report of the fourth PSR before 30 April 2015 for approval to the regulatory body. This fourth PSR report must contain a list of corrective actions and/or safety improvements and a schedule. One reason for this ruling is to reschedule the PSRs to the original 10 year interval, based on the commissioning of the plant in 1975.

Without a PSR that has been performed during a reasonably short time period before its final approval there is a risk that the outcome of the PSR will be based on old facts, and that analyses performed at different time intervals may not account for changes in safety requirements, ongoing plant modifications and accumulated operating experience. Consequently the PSR will not serve its purpose of being valid for the next ten years and providing relevant and valid input to plant documentation.

Suggestion: The plant should consider all necessary measures to ensure the finalization of the third PSR as currently scheduled, before the end of 2011.

Basis:

INSAG-14

Principle:

46. *The reference safety level of a nuclear power plant is improved as far as reasonably practicable throughout its operating lifetime, taking into account advancements in knowledge, notably through the feedback of operating experience, and the safety levels of newer plants.*

48. Here it is emphasized that, where reasonably practicable, this reference safety level is improved over time. The rationale is that the expected operating lifetime of a nuclear power plant covers decades; what was once considered an acceptable safety level may be judged insufficient 30, 20 or even 10 years later.

Principle:

61. Safety reviews are undertaken to provide an overall view of the actual safety status of a nuclear power plant. They include a determination of whether its ageing is being effectively managed as well as a discussion on the possible evolution of its reference safety level.

62. Safety reviews of the overall technical status of each individual plant, which look forward over a sufficiently long period of potential future operation of this plant (for example ten years), are undertaken to provide confidence that it would be technically feasible to operate the plant in consistency with the applicable safety requirements during the further operating period. Safety reviews take into account the reference safety levels for newer plants as well as the developments in technology and advancements in underlying scientific knowledge and analytical techniques.

63. Safety reviews provide important inputs into the decisions of the operating organizations on the further operating times of the plants and on the investments that they are prepared to make to secure those operating times.

NS-G-2.10

3.5. The PSR should be conducted typically every ten years and its duration should not exceed three years. The starting point of a PSR is the time of the agreement between the operating organization and the regulatory body on the general scope and requirements for the PSR and its expected outcome. The end point of a PSR is the approval by the regulatory body of an integrated programme of corrective actions and/or safety improvements (containing a list of corrective actions and/or safety improvements and a schedule). (In general, adequate documentation of the design basis and of probabilistic safety assessment (PSA) is needed for a PSR. If such documentation is not readily available and a major effort would be necessary to obtain it, consideration should be given to obtaining it by means of projects separate from the PSR.)

5.5. HANDLING OF FUEL AND CORE COMPONENTS

5.5(a) Good Practice: The fuel department has compiled a pocket size book that is easy to use and provides a short and easy to read description of tools, equipment and installations used for handling of fuel and core components. The pocket-size book is called the “Fuel Bible”.

The book is easy to carry and is used by the fuel handling operators and maintenance teams. It is also used as an aid in training. The short descriptions of tools and equipment are complemented with graphics and pictures to support the text. The book is not a substitute for procedures, but provides comprehensive descriptions to help the operators, and gives answers to frequently asked questions.

6. OPERATING EXPERIENCE FEEDBACK

6.2. REPORTING OF OPERATING EXPERIENCE

Some internal Operating Experience reports which meet external reporting criteria identified in plant procedures were not reported to the industry, and those which were reported were not done so in a timely manner. The team suggests that the plant consider reporting appropriate internal OE information in a more timely fashion to international organizations such as WANO.

6.5. ANALYSIS

The team found that some event analyses are not being performed with the appropriate depth and rigor, and some analyses are not being completed in a timely fashion. The team recommends that the plant improves the analyses of events or incidents in order to effectively identify the most beneficial corrective actions and implement those actions in a timely manner.

Management review of completed analysis lacks a check list to ensure the steps required for quality of the analysis are properly completed. The plant is encouraged to improve oversight of completed analyses by utilizing tools such as score-sheets for the key points of the analysis process, in order to prevent missing any of the important steps and in order to ensure quality, during management review and approval of the analyses.

The procedures at the plant do not identify detailed steps required to ensure corrective actions are implemented as intended by the analysis. The plant is encouraged to perform effectiveness reviews of important corrective actions and corrective action plans, clearly defined as actions in those corrective action plans (CAP). These are typically performed 3 to 6 months after the last action in a CAP is complete. These reviews should also utilize tools such as score-sheets, to be used by a management review in order to ensure the quality and effectiveness of the implementation of the corrective action/s.

6.7. USE OF OPERATING EXPERIENCE

The plant uses standard tagging lists for repeating equipment isolations and un-isolations. These lists have OE information added directly into the tagging lists where applicable, including detailed notes and references. The team considers this to be a good performance.

The plant shares OE between production divisions (nuclear, conventional) by writing “OE Flashes” which are lessons learned bulletins from applicable experiences, and communicating them directly to the other divisions. The plant also receives OE Flashes from other divisions and screens this information as part of the incoming OE screening and analysis process. The team considers this to be a good performance.

At the plant it is mandatory for Post Job Debriefing results (PJDB) to be recorded into work orders before the work orders will progress to Completed status. In addition, the completion rates of the PJDB results are tracked and trended. The team considers this to be a good performance.

6.9. ASSESSMENT AND INDICATORS OF OPERATING EXPERIENCE

Self assessment exercises are performed individually by each team at the plant. The results of these exercises at team level are also grouped at section level, presented to the section manager and discussed, then used as an input for the section self assessment. The team considers this methodology for self assessment as a good practice.

DETAILED OPERATING EXPERIENCE FINDINGS

6.2 REPORTING OF OPERATING EXPERIENCE

6.2(1) Issue: Some operating experience analysis reports which meet external reporting criteria identified in plant procedures are not reported to the industry, and those which are reported are not done so in a timely manner.

- Event report 17536 (03Jul2009); following a failed monthly load test of a safety diesel generator, further investigation learned that the injection pump of the generator was obstructed because the plunger was jammed. The plunger did not meet the correct specifications. This event was not reported to the industry.
- Event report completed January 18, 2010 on caustic soda industrial safety event was found not to have been reported to the industry.
- Event report 16432 (16Dec2008); after the monthly test of the isolation of the blow down circuit (BD), the shift team noticed that the bypass valves of the penetration valve were in an open position. This incorrect alignment was caused by un-tagging operations five days earlier. This INES level 1 event was not reported to the industry.
- Event report 17224 (10Aug2009); during tests of the recalibration of the reactor power chains, using partial flux charts, incorrect values were used to determine the reference values of the unit: values from another unit were mistakenly used for the incident unit. Because of this, the axial power imbalance of the plant was outside its reference area by +/- 5%. This reactivity management event was not reported to the industry.
- Event report 17905 (14Sep2009); during the decennial design review, some parts of the polar bridge in the reactor building were found not to be in accordance with the single failure proof requirements for loads up to 2700kN (NUREG). This was not in accordance with plant technical specifications. This INES level 1 event was not reported to the industry.
- Root Cause Analysis report 10010000932 on an event involving a spill of radioactive resin was not posted to the industry. This event clearly meets the guidelines in the procedure ERV/01, and ERV/Q/01. When asked, plant staff stated the rationale for not reporting it was that it happened in the Waste Auxiliary building.
- Event report 15466 (22May2008); during cooling transitions prior to the outage, a safety injection (SI) valve was tagged for maintenance work. However, according to plant technical specifications, this part of the SI system is required during the transition phase. This INES level 1 event was not reported to the industry.
- Plant reports to the industry were posted in an average of about 102 days. No target for timeliness of reporting exists in plant OE procedures, and 102 days is more than double the WANO median for the better performing plants.

Without the appropriate level and timeliness of reporting to the industry, Nuclear Power Plants in National and International organizations cannot benefit from other’s experiences in order to improve the operational safety of the nuclear industry as a whole.

Suggestion: The plant should consider reporting more internal operating experience information in a timely fashion, to international organizations such as WANO.

Basis:

NS-G-2-4

6.62 In-house events of interest to other plants should be shared with the industry to prevent the occurrence of similar events.

NS-G-2-4

6.65 Similarly, the operating organization should obtain and evaluate information on operating experience at other plants that provides lessons for the operation of its own plant. To this end, the exchange of experience and its contribution to national and international organizations should be considered to be of paramount importance.

NS-G-2-11

7.4 For maximum impact and benefit, appropriate information relating to the feedback of operational experience should be disseminated to relevant bodies. This should occur at appropriate levels (e.g. the plant level, the operating organization level, and the national and international level).

NS-G-2-11

7.5 The dissemination of information involves a number of organizations, such as the regulatory body and the operating organization, and use should be made of the centralized international reporting system set up by the IAEA and OECD/NEA and by WANO, although other arrangements that fulfil the same objectives may be adopted.

NS-G-2-11

7.6 By actively participating in the programmes for the dissemination and exchange of information, the originator should also benefit from the increased opportunity for receiving feedback from other organizations and service providers. In this way dissemination leads to a more broadly based effort to enhance safety by using operational experience from nuclear installations and other related industries. It may contribute to the effectiveness of decision making at the affected organization and it may enhance the confidence of the regulator in the safety of the operation of the plant.

6.5. ANALYSIS

6.5(1) Issue: Analyses for some events are not being performed to the required depth and rigor described in the plant programs, and are not being completed in a timely fashion.

- The causal tree analysis performed for event report MF 18074 on a worker's fall from a ladder which resulted in a deep cut to the forehead and potential broken ribs, did not investigate the quality of error prevention methods used by the contract organization of which the worker belonged. Items such as supervision level, supervision practices, quality of pre-job briefings and other error prevention techniques were not examined by the analysis. Extent of condition / extent of cause are also not identified.
- The root cause analysis performed for event report MF 18456 which was an INES level 1 event involving a valve found open when it was tagged as closed, came to the root cause of WANO code 0001 "Unidentifiable". The corrective action however, discusses that supervision of the works was split between two people and in the future one supervisor will be responsible. No further analysis was identified on the supervision practices which allowed the event to occur. Extent of condition / extent of cause are also not identified.
- The root cause analysis performed for INES level 1 event report MF 18497 in which two 100% duty compressors (VE2C53A and B) would not correct system pressure properly due to a blind flange left installed in the common outlet piping during the outage works, did not identify how the flange got overlooked. No analysis of the supervision techniques / methods, or the working methods of the workers involved was performed.
- Plant OE program performance indicator "run-through times" (time of event to analysis finished, 12 months floating) shows 50% of all take > 90 days (procedure target is 90 days). The 12 month rolling median for better performing plants is 50 days.
- Root cause analysis report 10001873240 from October 2008 identifies that internal OE from a previous event in 2000 was not effectively used to improve the procedure for radioactive resin transfer in the Water and Waste processing Building (WAB), resulting in a repeat event involving a radioactive resin spill in the room WAB0345 (same valve as in 2000 was inadvertently positioned open).
- The plant does not have a process for analysis lower than root cause but higher than technical analysis, resulting in some medium level events not identifying the reasons why the direct causes occurred. Apparent cause analysis and equipment apparent cause analysis are two such examples, including relevant supporting tools such as worksheets.

Without thorough and timely analysis of appropriate reports, including precursors, near misses, accidents and unauthorized acts (especially those issues potentially relevant to the safety of the plant), the collection and analysis of the data cannot effectively be used to prevent repeat events, or more serious events.

Recommendation: The plant should improve the analyses of events or incidents in order to effectively identify the most beneficial corrective actions, and implement them in a timely manner.

Basis:

NS-R-2

2.21. Operating experience at the plant shall be evaluated in a systematic way. Abnormal events with significant safety implications shall be investigated to establish their direct and root causes. The investigation shall, where appropriate, result in clear recommendations to the plant management, which shall take appropriate corrective action without undue delay. Information resulting from such evaluations and investigations shall be fed back to the plant personnel.

NS-G-2.11

4.10 It is common practice that organizations regularly involved in the evaluation process use standard methods to achieve a consistent approach for the assessment of all events. These standard methods usually involve different techniques. Each technique may have its particular advantages for cause analysis, depending on the type of failure or error. It is not possible to recommend any one single technique. Either one technique or a combination of techniques should be used in event analysis to ensure that the relevant causes and contributing factors are identified, which aids in developing effective corrective actions.

NS-G-2.11

5.2 The development of recommended corrective actions following an event investigation should be directed towards the root causes and the contributory causes, and should be aimed at strengthening the weakened or breached barriers that failed to prevent the event.

NS-G-2.4

6.64 The operating experience at the plant should be evaluated in a systematic way, primarily to make certain that no safety relevant event goes undetected. Low level events and near misses should be reported and reviewed thoroughly as potential precursors to degraded safety performance. Abnormal events important to safety should be investigated in depth to establish their direct and root causes. Methods of human performance analysis should be used to investigate human performance related events. The investigation should result in clear recommendations to plant management, which should take appropriate corrective action without undue delay to prevent recurrence.

6.9. ASSESSMENT AND INDICATORS OF OPERATING EXPERIENCE

6.9(a) **Good Practice:** "Yellow Sticky" self assessment exercise

Self assessment exercises are conducted at all levels, including workshop level, as well as at different process levels (process, sub process).

Inputs consist of event reports, field observations, external and internal audit reports, QC findings, good practices and guidelines, etc. Self assessment exercises are held with the whole team using these inputs. During these self assessments, the team scores itself on a set of competency grades to measure safety culture and the quality of human behavior, and to measure the maturity of the team or individuals in the use of each Human Performance tool.

These self assessment exercises are performed individually by each team at the plant. Important internal event reports together with observation reports from the past year are cataloged into the three Defence-In-Depth barriers by use of a predefined tool.

Preparation is done by the OE manager from the individual department, in close cooperation with the Human Performance (HU) section and the applicable team line manager. The choice of event reports and observation forms is focused on the team which performs the self assessment.

The standard agenda of this yellow sticky exercise is as follows:

- Analysis of observation sheets (in small groups) specific to the team (behavior)
- Analysis of event reports (in small groups) specific to the team (design, work practices, behavior)
- Presentation and discussion regarding the biggest technical issues affecting the team (equipment / design)
- Presentation and discussion regarding rework by the team (if applicable) (work practices, behavior)
- Presentation and discussion regarding nuclear safety (work practices, design, behavior)

The statistics which result from the assessment are then discussed by all members of the team. A self reflection session on Design, Work Practices and Behavior is then initiated with the team supervisor as a key player. The exercise is also facilitated by the section Manager and the OE manager from the concerned department, along with the HU section.

At the end of the exercise, the Team Supervisor determines the important issue/s in the conduct of operations in relation to which they want the team to improve over the next year. These issues are included in the objectives of the Shift Supervisor in order to stimulate improvement. The exercise results in actions for the team and for individuals.

The effectiveness of the improvement action/s is evaluated by the team the following year.

The results of the Yellow Sticky exercises at team level are also grouped at section level, presented to the section manager, and discussed so that they are used as an input for the section self assessment. The results of the Yellow Sticky exercises of the teams within a department are used as one of the inputs for the Department Self Assessment.

7. RADIATION PROTECTION

7.1. ORGANIZATION AND FUNCTIONS

Good cooperation and awareness on radiation protection issues have been developed throughout the whole organization. Radiation protection staff are involved in continuous improvement. The team finds the low threshold on reporting incidents within Radiation Protection a good performance.

7.2. RADIATION WORK CONTROL

There is a comprehensive and systematic survey program of radiation and contamination levels in the RCA. A graphic computer system where survey results are archived was found by the team to be a good performance.

Where elevated radiation levels occur, the locations of components are listed outside rooms. A significant decrease in search doses (dose associated with locating the component) has been achieved, and the team regards this as a good performance.

Index cards describing radiation protection measures as well as the protective clothing and equipment needed for a variety of activities are a practical tool for implementation of ALARA principles. The team has identified this as a good practice.

7.3. CONTROL OF OCCUPATIONAL EXPOSURE

Performance indicators on occupational exposure were found to be good. Rigorous radiation work preparation and the dose reduction plan have contributed to these results.

The plant has developed rapid methods for dose estimation in the event of external or internal contamination. The methods are documented and trained frequently for selected radiation protection staff and all health surveillance staff. The team considers these methods a good performance.

The team encourages the plant to take further action to systematically monitor the stellite inventory in the primary circuit and address the issue of loose pieces of paint originating from rails in the foreign material exclusion (FME) area near the fuel pools.

The team has identified some deficiencies in the condition of surfaces in the radiation controlled area which do not support easy decontamination, and has made a suggestion that RP should take more initiative in this respect.

The practice of training some radiation protection personnel to be qualified protective equipment dressers was found to be unique. The team has identified this as a good practice.

7.4. RADIATION PROTECTION INSTRUMENTATION, PROTECTIVE CLOTHING, AND FACILITIES

Minor shortcomings were observed in the test procedures for radiation monitors. The checklist did not include a step to make sure that the correct measurement channel was being tested, and a step to inform operators of completion of the test was also missing. The team encourages the plant to review the test procedure for fixed radiation monitors, and to take any feasible corrective actions to enhance the procedure.

7.5. RADIOACTIVE WASTE MANAGEMENT AND DISCHARGES

With regard to radiological impact on the environment, the local legislation requires the plant to report activity releases, while environmental monitoring is the responsibility of the government. The plant does not currently measure carbon-14 releases. A report on estimated carbon-14 releases was reviewed and found satisfactory. The plant intends to start online measurement of tritium and carbon-14 releases, and the team encourages the plant to pursue this effort.

7.6. RADIATION PROTECTION SUPPORT DURING EMERGENCIES

Radiation protection support for emergencies, including dose estimation methods for on-site doses and off-site doses, training and drills, was reviewed and found satisfactory. The good practice on EPP training 9.7(a) also applies to radiation protection.

DETAILED RADIATION PROTECTION FINDINGS

7.2. RADIATION WORK CONTROL

7.2(a) Good Practice: Index cards are available describing radiation protection measures as well as the protective clothing and equipment needed for a variety of activities.

The radiation protection department has developed descriptions of a number of standard maintenance tasks (in the form of index cards). The index cards contain the following:

- A description of the functional location
- A brief description of the work, including whether there are any requirements relating to the task according to Technical Specifications
- Radiation protection measures needed for the task
- Protective clothing and equipment needed for the task
- Measures to be taken by the Maintenance department

Index cards also exist for some generic activities. The index cards are available at the radiation protection counter at the entrance to the radiation controlled area. Whenever work is to be carried out, radiation protection staff follow the instructions on the index card to prepare the radiation protection measures needed at the work site.

The index cards are compiled by all radiation protection staff and submitted to review. Periodic review of the index cards is also carried out.

The identified benefits of the index card system are:

- Minimized possibility of errors when preparing radiation protection measures for a work site
- Minimized dose in work site preparation
- Time saved in work planning
- Operational experience of work involving a radiation risk is transferred when index cards are updated.

Evidence of the effectiveness of the system is that the performance indicators for collective work dose at the site are within the best quartile of the industry.

7.3. CONTROL OF OCCUPATIONAL EXPOSURE

7.3(a) Good Practice: Staff have been trained to assist in the proper usage of protective clothing and equipment to prevent personal contamination and prevent spreading of contamination.

All radiation protection staff and selected radiation protection contractors are trained in appropriate dressing and undressing procedures for protective equipment. Training is conducted in facilities simulating the radiation controlled area, located at the plant's training centre. Training includes lectures to explain and highlight the importance and benefits of correct usage of personal protective equipment in the radiation controlled area. Demonstrations and practical rehearsals are carried out with all personal protective equipment used in the radiation controlled area. The examination to obtain the dresser certificate contains both written and practical sections. A refresher course is performed annually.

The plant has experienced some cases of group contamination in recent years. Analysis of these cases identified procedures for removing personal protective equipment as one of the reasons for contamination. The "trained dresser" practice has been integrated into the plant ALARA process and dose reduction program. Since the practice was introduced, the number of external contaminations has decreased. Evidence of the decrease in contamination cases is clear.

The use of trained dressers was found by the team to be quite unique and innovative. The practice would be relatively easy to implement in other installations. The benefit of the practice has been seen in the reduction in the number of cases of personnel contamination. When trained dressers are used, radiation protection staff can focus on their other activities.

7.3(1) Issue: Radiation protection is not taking sufficient initiative to ensure that the condition of surfaces in the radiation controlled area (RCA) is adequate to enable easy decontamination.

The overall condition of surfaces is satisfactory, and signs of recent repairs were noted. However:

- There are broken epoxy coatings on pump support frames in rooms GNH105 and GNH109.
- Unrepaired damage was observed on walls in rooms GNH108 and GNH405.
- Room GNH213, containing liquid waste pipelines, has an unpainted floor. There is no documented ALARA analysis to explain the situation.
- One wall tile was broken in the personnel decontamination room.
- Minor damage to the surface coating of the concrete slab above pool filters is present in the main hall of the nuclear auxiliary building.

Without properly decontaminable surface conditions in the RCA, persistent contamination can occur leading to unnecessary increase of personal and collective dose.

Suggestion: Radiation protection should consider taking the initiative, in accordance with ALARA principles, to enable timely and exhaustive maintenance of surface coatings in the RCA.

Basis:

NS-G-2.7

3.2 The radiation protection programme should be based on a prior risk assessment in which the locations and magnitude of all radiation hazards have been taken into account…
(i) removal or reduction in intensity of sources of radiation
3.67 For the control of radiation exposure of personnel, consideration of the optimization of radiation protection is required in the design and operation …
(b) reducing surface and airborne contamination

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I.21. "Registrants and licensees shall designate as a controlled area any area in which specific protective measures or safety provisions are or could be required for... (b) preventing or limiting the extent of potential exposures."

8. CHEMISTRY

8.1. ORGANIZATION AND FUNCTIONS

Chemistry Department supports Operation Department in certain engineering roles in the field such as setting chemical specifications, choosing filters and resins. The team considered this is a good performance.

The team identified as a good practice the specific, well-defined training and "cross training" of chemistry staff, which is a strength in terms of safe operation.

8.2. CHEMISTRY CONTROL IN PLANT SYSTEMS

In all operational conditions – normal operation, start up, shutdown, hot shutdown – water chemistry criteria and specifications are well defined in CHEM/02 and CHEM/05. In some situations, chemistry expectations are stricter than expectations of technical specifications. This is a strength in terms of good water chemistry. The team considered this is a good performance.

The Chemistry Department has its own startup/shutdown procedures. The procedures are cross-linked with the procedures of the operations team in the control room, indicated as REF. BE/SCH. Before and after every outage, a pre-outage and post-outage briefing is organized. In the post-outage review, all remarkable issues and the most important events are discussed for future integration into procedures. The team considers this as a good performance.

8.3. CHEMICAL SURVEILLANCE PROGRAMME

The Laboratory Information and Management System (LIMS) is effectively used for scheduling chemical analyses. On-line parameter results are input directly into the operational management system (DIMOS). The control room personnel have a facility to allow them to track chemistry parameters. Evaluation of chemistry data is well supported by the independent review and expertise of the external laboratory LABORELEC. The team considered this is a good performance.

8.5. LABORATORIES, EQUIPMENT AND INSTRUMENTS

The chemistry laboratories of Doel 1 & 2 and Doel 3 & 4 are equipped in the same way, so that redundancy is ensured. Inductively Coupled Plasma (ICP) analyzer is available only at Doel 3 and Total Organic Carbon (TOC) analyzer is available only at Doel 4 laboratory. The analysis plan for Doel 1 & 2 is integrated into the Doel 3 and Doel 4 analysis schedule, and transport is well organized and described. The team has identified this as a good performance.

8.6. QUALITY CONTROL OF OPERATIONAL CHEMICALS AND OTHER SUBSTANCES

Although the storage and labeling of chemical products are approved, the team observed that in some cases there is no guarantee that all chemicals meet expectations. There is a potential risk of personal injury and equipment damage. The team suggests improving the storage of chemicals, and encourages the plant to label all chemicals in accordance with applicable procedures. Moreover, this process should provide benefit in terms of safe work with chemicals.

DETAILED CHEMISTRY FINDINGS

8.1. ORGANIZATION AND FUNCTIONS

8.1(a) Good Practice: Chemistry staff are 'cross-trained' in Doel 1/2 and Doel 3/4 systems.

Doel NPP operates units 1 and 2 with 433 MWe net power each, and units 3 and 4 with 1006 and 1040 MWe net power respectively. Units 1, 2 and units 3, 4 of the plant are of different PWR designs. Consequently the names of the plant systems, the location of the sampling points and the process computer are different for Doel 1, 2 and Doel 3, 4. The chemistry specifications are similar, but have some differences for Doel 1, 2 and Doel 3, 4. The laboratory equipment and the counting room are the same for both Doel 1, 2 and Doel 3, 4.

The chemistry service provides 'cross training' for chemistry technicians, whereby technicians from units 1, 2 are also trained to work on units 3, 4 and vice versa.

- The training program is specific, well-defined and comprises both theoretical and practical parts. It covers all subjects which are different for units 1, 2 and units 3, 4.
- The training is required by and defined in a procedure.
- The training includes initial training and annual retraining.

The benefits of 'cross-training' for the plant include greater flexibility to assign staff to cover higher workloads, and the ability to ensure sufficient staffing in emergency or epidemic situations.

8.6. QUALITY CONTROL OF OPERATIONAL CHEMICALS AND OTHER SUBSTANCES

8.6(1) Issue: Storage of chemicals and other substances is not always appropriate.

- The gas cylinder located in room GNH 560 containing air for the pneumatic valves in the post accident liquid sampling system (PALSS) and boron analyzer systems was not labeled empty or full.

- In the laboratory sample store, one of the waste samples to be transferred to the WAB building was identified without labeling. On top of stored bottles there was a printed list showing “waste” only.

- Outside of waste collecting point number 3 (WAB3), two temporary storage locations for waste chemicals were observed. The fenced area with metal drums is not labeled as a waste storage location.

- The function of WAB3 is to store different types of non radioactive waste. The building area is divided for selective storage, for example chemicals which are past their expiry date. Some storage places with liquid retention facilities do not have a list of contents stored there.

- In WAB3 it is not easy to reach the absorbent materials in case of leakages, as they are stored between the chemicals, and not separately.

- “Kemet” liquid was found in a small container in the maintenance workshop in building CGA without a label, and only with a hand-written mark which was difficult to read.

- Chemicals used were checked against the list of allowed products in the field. In some cases the names of the chemicals were the same as in the list, but the letter or number designations were not the same as in the list.

- In the warehouse (room number: MAZ 286) for chemical products, the floor does not have an epoxy coating. In case of leaks, the chemical would penetrate into the concrete floor of the building.

- Two metal drums were stored directly on the floor and did not have a wooden pallet or a safety tray (to capture spillages). At this location the floor was wet. Direct contact between metal drums and a wet floor can lead to corrosion of the drums.

Without proper control of storage of chemicals and other substances there is a risk of personal injury and equipment damage.

Suggestion: The plant should consider improving control of chemical storage to avoid potential risk to system components and personnel.

Basis:

DS 388:

9.3. The intrusion of non-conforming chemicals or other substances into plant systems can result in chemistry excursions leading to component and system damage or increase of dose rate.

9.9. Chemicals and substances should be labelled according to the area where they can be used, so that they can be clearly identified.

9.10. When transferring a chemical from a stock container to a smaller container, the latter should be labelled with the name of the chemical, date of transfer and pictograms to indicate the risk and application area. The content of the smaller container should not be transferred back into the stock container. Residues of chemicals and substances should be disposed of according to the plant procedure. Quality of chemicals in the open stock containers should be periodically checked.

Safety in the use of chemicals at work – ILO

6.7.3. Control measures to provide protection should cover any combination of the following:
(c) adequate security of and access to storage areas.
(g) adequate precautions and procedures in case of spillage
(j) labeling and relabeling requirements

9. EMERGENCY PLANNING AND PREPAREDNESS

9.1. EMERGENCY PROGRAMME

The planning basis on which the reflex zone of 3.5 km is based is an Electrabel document titled “Nucleair en Radiologisch Noodplan voor het Belgische Grondgebied, Reflexfase NR/UR : voorstel Electrabel”. The radiological events on which the plan is based, and their potential consequences, are contained in the emergency plan (NP-12 and NP-13). The Eenvironmental Section of the Care Department has performed a risk assessment related to dangerous material at the site. Work is underway to examine the potential external events that could affect the site, including non-radiological events. For example, the plant now recognizes the specific issues associated with potential off-site chlorine releases, and the challenges associated with the fact that this is a heavy gas. The plant is encouraged to complete its assessment of off-site risks that could impact the site, including chlorine, and to incorporate the findings in the emergency plan.

There is no procedure to pre-identify and retain essential (but non-emergency response) personnel at the station during a site evacuation. Some personnel (e.g. systems engineers, etc.) are essential to support the operating crew in managing the emergency during complex events. That personnel is normally, according to best practice, pre-identified and aware that, during an emergency leading to a site evacuation, they may need to remain at (or come back to) the station to support the operating crew. There is no list of who should be considered essential personnel at this station. However, there is a procedure to identify key personnel at the assembly points before a site evacuation; but this process is ad-hoc. The station has recognized the need to formalize this system. The plant is encouraged to develop and implement an emergency procedure based on the pre-established list of personnel that could be required to stay at the site during a site evacuation.

9.2. RESPONSE FUNCTIONS

The person authorized to classify an emergency and initiate the off-site notification is duty role 1 (wachtrol 1), who is not present at the site at all times. The team has made a recommendation on this subject.

There is a very good working relationship between the hospital and the site for the management of potentially contaminated victims, the procedures are very well coordinated and drills are regularly conducted. Arrangements are being made to add a video link between the hospital and the triage area at the plant. The hospital is proactive and enthusiastic in its preparedness and has, with the help of the station, developed plans to accept a large number of patients from the plant. The team has identified this aspect of medical preparedness as a good performance.

The assessment of off-site consequences of accidents is based on dose projections from a model run on the basis of plant parameters, measured releases or pre-established scenarios. The plant also measures off-site dose rates and contamination levels at pre-determined points and according to a well established survey strategy; the team considers this a good performance.

To assist decision makers in understanding the magnitude of a release, the plant has developed "rules of thumb" cards that relate simple parameters to potential accident severity. This is a quick and standardized way of assessing the situation. The team considers this a good performance.

The relationship between the site and the fire fighting organization from Beveren, which is the main off-site fire fighting support organization, is excellent. The station has provided training and familiarization visits of the plant to some fire department personnel. However, the training program for off-site fire fighters is not systematic or formalized, and there is no common protocol for the joint intervention and radiation dosimetry of off-site and on-site fire fighting teams. The team has made a recommendation with regards to this area.

The procedure for the prompt release of media information in the initial phase of the emergency is clear, simple and practical. It is based on a set of well designed pre-written messages adapted to a wide spectrum of possible events. This approach constitutes a quick and reliable way to inform the media and the public without delay following an emergency event. The team considers this a good performance.

9.3. EMERGENCY PLANS AND ORGANIZATION

The main emergency plan manual contains background information (sections 1 to 4), a section with the instructions to the key emergency roles (section 5), references to supporting procedures for the key emergency roles (the NPs), and references to the internal departmental emergency procedures, when relevant to the key emergency role (the wachtrol). Together, all the emergency response documents fulfill the main requirements contained in the international standards and guidance. However, it was recognized by the plant emergency planning staff that the emergency document structure could be improved, simplified and consolidated to make it more effective and more useful in the high-stress environment of an emergency. Therefore, the plant is encouraged to pursue the simplification of its emergency planning and response documentation.

There are emergency procedures for dealing with severe accidents (what is often known as Severe Accident Management Guidelines, or SAMGs): the bedrijfskamer procedures (BK procedures). These procedures, which are under the control of the operations department, have an important role in the emergency response plan. At the moment, those SAMGs are executed by one or more operating engineer (the wachtrol-2), and it is the intent of the plant to enhance the link between this team and the On-Site Technical Support Centre (OTSC) and the safety analysis support organization (Tractebel). The plant is encouraged to continue this effort to achieve close cooperation between the BK, the OTSC and the safety analysis support organization, as well as to plan the communications links between these teams, and to exercise them.

By and large, all required outputs of the emergency preparedness process, such as training and exercises programs, equipment maintenance, etc. are described in the suite of emergency planning documents. However, there is no emergency preparedness management document or section in the emergency plan that describes, in a consolidated way, all the preparedness activities, commitments and coordination mechanisms, internal and external, that are part of the day-to-day management of this process. This was exemplified by the fact that KCD has a seat at the provincial emergency preparedness committee but this is not documented in the internal emergency preparedness documents. While this does not affect the very good coordination that the plant currently enjoys with the off-site authorities, it highlights the need to formalize the emergency preparedness arrangements and activities currently in place. The plant is encouraged to continue to formalize the existing emergency preparedness arrangements and processes in a consolidated document that can be used to guide the preparedness management process and to provide continuity when responsible personnel are changed.

9.5. EMERGENCY RESPONSE FACILITIES

Although severe accidents may not constitute the fundamental basis for the detailed planning arrangements, not taking them into account, or addressing them in contingency arrangements, could render the emergency plan ineffective when it is most needed. For example, the OTSC is vulnerable to high environmental dose rates that could result in the case of a severe accident, but there is a backup for that facility, namely the OTSC of Doel 3&4 (and vice versa). An analysis has been performed to demonstrate that the dose to the OTSC members during a design basis accident would be acceptable. However, no analysis has been performed to demonstrate that this would hold true during a severe accident. Indeed, it is likely that this space may not be suitable for some severe accidents. It is recognized by the plant emergency staff that there is a need for contingency arrangements and improvisation during such events, and the emergency planning personnel have stated that the emergency response centre (NPK) or other OTSC could be used in this case. The plant is encouraged to formalize these arrangements.

9.6. EMERGENCY EQUIPMENT AND RESOURCES

The plant has a comprehensive database of all equipment intended to be used for emergencies. This comprehensive equipment management system ensures that the equipment is fit for duty and provides a demonstrable, effective and reliable way to ensure that all the equipment required to manage emergency response is available for emergencies. The team acknowledges this as good practice.

9.7. TRAINING, DRILLS AND EXERCISES

The plant has a well-documented statement of required capabilities and knowledge for each of the positions identified in the emergency plan. For each “person”, based on their knowledge and experience, the plant designs an individualized training program to allow the individual to achieve the required level of performance. This system ensures optimal performance of the emergency response teams against clearly defined standards. The team acknowledges this as good practice.

DETAILED EMERGENCY PLANNING AND PREPAREDNESS FINDINGS

9.2. RESPONSE FUNCTIONS

9.2(1) Issue: Outside of working hours, there is no one required to be present at the site who has the responsibility or the authority to classify an emergency or to notify off-site authorities.

When an emergency occurs outside working hours, duty-role 2 (wachtrol-2), who is not required to be present at the site, is notified and must be present at the site in 15 minutes. Duty-role 2 must then notify duty role-1, who is also not required to be present at the site, and who is the one authorized to classify the emergency and to trigger the full escalation of the on-site emergency plan.

Without a person present at the site to classify an emergency and promptly initiate the off-site notification, the effective initiation of off-site protective actions can be delayed.

Recommendation: The plant should designate a person who is present at the site at all times and who has the authority and responsibility to classify a nuclear emergency and notify appropriate off-site organizations.

Basis

GS-R-2

4.23: “Each facility or practice in threat category I, II, III or IV shall have a person on the site at all times with the authority and responsibilities: to classify a nuclear or radiological emergency and upon classification promptly and without consultation to initiate an appropriate on-site response; to notify the appropriate off-site notification point (see para. 4.22); and to provide sufficient information for an effective off-site response. This person shall be provided with a suitable means of alerting on-site response personnel and notifying the off-site notification point.

9.2(2) Issue: There is no written common response protocol or systematic training program for the off-site fire fighting teams expected to support the on-site fire brigade.

The relationship between the site and the fire fighting organization from Beveren, which is the main off-site fire fighting support organization, is excellent. This was exemplified by discussions, meetings and presentations by the Beveren fire department, in which both plant representatives and delegates from the federal authorities were present, and through which all parties displayed an exemplary meeting of minds with regards to cooperation. Furthermore, the station has provided training and familiarization visits of the plant to some fire department personnel. However:

- The training program is not formalized.
- There is no joint procedure between the Beveren fire department and the site fire brigade. Although presentation material suggests that many details have been worked out, these details are not captured in any formal document.
- The dose and dose rate alarming levels for the fire department equipment and procedures are different from those that are preset in the dosimeters that the fire fighters are expected to receive from the site when entering. Internal fire departments limits are 2 mSv (on their personal dosimeters) and 25 microSv/h (on the team's dose-rate meter), while the levels set in the site dosimeters are 10 mSv and 30 mSv/h. There is no documented evidence indicating which levels will apply to the fire fighters at the site, or which equipment they would be using as the primary ones. For example, should the off-site fire fighters use their own dose-rate meter, the alarm would go off at 25 microSv/h, while it can be reasonably expected that, based on the site dosimeters, they could work in areas where the dose rate is up to 30 mSv/h (which is over 1000 times higher).
- There is no formal training or visit program that would ensure that all off-site fire fighters that could reasonably be expected to respond to a site fire event, possibly in the Radiation Controlled Area ("warm" zone), are familiar with this area and with the risks present, i.e. that could alleviate the concern that many fire fighters, based on experience in other countries, could experience when entering a "radiation" area.

Without an appropriate training and familiarization program, common procedures and agreement between the site and the off-site fire fighters, there is a real risk that, during an actual emergency where radiation may be present (as opposed to exercises, where radiation is simulated), there could be confusion, misunderstanding and delays, which could significantly affect the effectiveness of the fire fighting response.

Recommendation: The plant should develop a joint agreement on common response protocol and a systematic training and familiarization program for off-site fire departments expected to provide support to the on-site fire brigade in case of fire.

Basis

NS-G-2-1

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

NS-G-2-1

3.2: "The documentation should identify the posts, specific responsibilities, authorities and chain of command for personnel involved in fire safety activities, including their relation with the plant organization. The areas of responsibility identified should include:

- […];
- emergency plans, including liaison with any off-site organizations that have responsibilities in relation to fire fighting"

NS-G-2-1

3.6: "Possible scenarios for fires that could affect safety should be considered in the emergency plan for the plant, which should include a description of the organization, responsibilities, authorities, chains of command, communications and means of co-ordination between the different groups concerned with fire. This should include consideration of both on-site and off-site resources, as appropriate."

9.6. EMERGENCY EQUIPMENT AND RESOURCES

9.6(a) **Good practice**: The plant has a comprehensive database of all equipment intended to be used for emergencies.

All equipment, instruments and logistics needs for all emergency management functions and facilities are inventoried in a centralized database (under SAP management system). The database contains a detailed description of the items, the frequency at which they need to be tested, the calibration requirements (for detection equipment) and the department responsible for their maintenance. A sample check of the instruments indicates that the detection instrument calibration is up to date.

This comprehensive equipment management system ensures that the equipment is fit for duty and provides a demonstrable, effective and reliable way to ensure that all the equipment required to manage emergency response is available for emergencies.

9.7. TRAINING, DRILLS AND EXERCISES

9.7(a) Good practice: The plant has a customized training program for each person in key emergency response positions.

The plant has a well-documented statement of required capabilities and knowledge for each of the positions identified in the emergency plan. For each “person”, based on their knowledge and experience, the plant designs an individualized training program to allow the individual to achieve the required level of performance. This includes self-studies, courses (with designated instructors), on-job training and drills. Following completion of the program and sign off, the individual is tested orally. If the results are not satisfactory, the individual is prescribed additional training. If successful, the individual receives a certification with a clear validity period. The performance of each individual is tracked, including the need for recertification. This is included in the personnel training database system of SCALDIS.

This system ensures optimal performance of the emergency response teams against clearly defined standards.

DEFINITIONS

DEFINITIONS – OSART MISSION

Recommendation

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

Suggestion

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

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

Good practice

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

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

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

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

LIST OF IAEA REFERENCES (BASIS)

Safety Standards

- **SF-1**; Fundamental Safety Principles (Safety Fundamentals)
- **Safety Series No.115**; International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources
- **Safety Series No.117**; Operation of Spent Fuel Storage Facilities
- **NS-R-1**; Safety of Nuclear Power Plants: Design Requirements
- **NS-R-2**; Safety of Nuclear Power Plants: Operation (Safety Requirements)
- **NS-G-1.1**; Software for Computer Based Systems Important to Safety in Nuclear Power Plants (Safety Guide)
- **NS-G-1.2;** Safety Assessment and Verification for Nuclear Power Plants (Safety Guide)
- **NS-G-1.7;** Protection Against Internal Fires and Explosions in the Design of 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-2-10**; Periodic Safety Review of 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)
- **GS-R-1**; Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety (Safety Requirements)
- **GS-R-2**; Preparedness and Response for a Nuclear or Radiological Emergency (Safety Requirements)
- **GS-R-3**; The Management System for Facilities and Activities (Safety Requirements)
- **GSR Part 4**; Safety Assessment for Facilities and Activities (Safety Requirements)
- **GS-G-2.1**; Arrangement for Preparedness for a Nuclear or Radiological Emergency (Safety Guide)
- **GS-G-3.1**; Application of the Management System for Facilities and Activities (Safety Guide)
- **GS-G-3.5**; The Management System for Nuclear Installations (Safety Guide)
- **GS-G-4.1;** Format and Content of the Safety Analysis Report for Nuclear Power Plants (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)
- **WS-G-6.1**; Storage of Radioactive Waste (Safety Guide)
- **DS388;** Chemistry Programme for Water Cooled Nuclear Power Plants (Draft 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
  - **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
- ***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-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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