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REPORT

OF THE

OPERATIONAL SAFETY REVIEW TEAM

(OSART)

MISSION

TO THE

DOEL

NUCLEAR POWER PLANT

BELGIUM

8 to 25 March 2010

and

FOLLOW UP VISIT

5 to 8 March 2012

DIVISION OF NUCLEAR INSTALLATION SAFETY
OPERATIONAL SAFETY REVIEW MISSION
IAEA-NSNI/OSART/157F/2012

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.

This report also includes the results of the IAEA's OSART follow-up visit which took place 24 months later. The purpose of the follow-up visit was to determine the status of all proposals for improvement, to comment on the appropriateness of the actions taken and to make judgements on the degree of progress achieved.

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. It also includes the results of the follow-up visit that was requested by the competent authority of Belgium for a check on the status of implementation of the OSART recommendations and suggestions.

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

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INTRODUCTION AND MAIN CONCLUSIONS

INTRODUCTION

At the request of the government of 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.

An IAEA OSART Follow-up team visited Doel NPP from 5 to 8 March 2012.

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.

DOEL NPP SELF-ASSESSMENT FOR THE FOLLOW-UP MISSION

In response to the OSART report, an elaborate action plan was drawn up in May 2010, including specific actions for each of the 15 issues, which was subsequently executed by the plant. The action plan for most issues related to all four units. Where the plan was only implemented at Doel 1 and 2, this is specified.

With respect to Industrial Safety, the focus was mainly on reducing possible fall, trip and bump hazards. To this end, several measures were taken, including the provision of over 1500 supplementary impact protection devices and/or additional signage and 2700 new lighting fixtures. Initiatives for continuous improvement of safety behaviour of plant employees and contractors were set up, including the launch of a Sustainable Safety Culture project in 2011. As a result, a clear improvement in safety results occurred, with both the severity and frequency rates falling by an average of over 50% for plant employees and contractors between 2009 and the end of 2011.

The methodology and requirements for the On the Job Training (OJT) were clarified and set out in a new policy document. About 200 new, standardised, OJT worksheets were produced across the various departments and the number of OJT trainers increased from 6 to over 40 people. The OJT trainers receive a more extensive training, leading to a formal certification.

For the habitability of the Doel 1 and 2 control room with respect to oxygen content, a detailed analysis was made for radiological accidents and toxic gas accidents. In the first case, additional monitoring of air quality was installed and resulting mitigation measures were incorporated into the existing accident procedures. In the second case, 150 supplementary compressed air cylinders were provided for control room personnel.

The condition of the cable galleries in the Doel 1 and 2 electrical buildings in terms of fire safety was physically improved via several measures. Over 1300 fire separation boards were renewed or remedied and a test-case with fire-retardant coating for cables crossing different polarities was successfully executed. More works are planned in the upcoming years.

The backlog of work orders was structurally reduced. New arrangements were put in place for scheduling works and assigning priority levels. A clear distinction between important (safety-related) backlog and non-important backlog was made and the backlog tracking tool was adapted in this sense. The total backlog decreased by 75%, while the important backlog was reduced by over 90%. There is a justification in place for each of the remaining important backlog orders.

For plant material condition, focus was put on deficiencies regarding cables, flanges, hangers and supports. Cable expectations were refreshed and incorporated into the 'electrician's notebook'. Over 500 cable deficiencies were corrected. For flanges, hangers and supports, a large-scale project is in place to address the issue in several steps. After an extensive walk-down of Doel 1 and 2 to determine the scope, a roadmap was developed encompassing both technical and organisational subjects. One key outcome was the production of an updated 'pipe spec', based on the latest technological developments. The actual remediation work, taking into account the importance of the deficiencies and other parameters, began in autumn 2011 and will continue in 2012.

The PSA model was updated with additional shutdown modes and recent relevant modifications.

A number of PSA applications were developed and/or refined and implemented at all units, such as the use of a Risk Matrix and PSA event analysis. Through optimized processes, dedicated teams and closer collaboration with the regulator, an important upgrade of the safety analysis report was achieved. To perform the Periodic Safety Reviews (PSR) in a timely manner, organisational measures were implemented in collaboration with the regulator, to guarantee the timely completion of the ongoing (third) PSR by the agreed date of 31/12/2011 and guarantee that the new (fourth) PSR gets performed in accordance with a strict planning. These measures led to the completion of all of the ongoing study topics by 31/12/2011.

Based on a benchmark, it was decided to report all events for which an incident report is required at Doel NPP - this automatically includes a root cause analysis - to WANO Paris Centre. The average reporting time was reduced to 10 weeks, half of the WANO average.

To further enhance the timeliness and quality of incident analyses, the existing procedures and expectations were enforced. The backlog in handling root cause analyses (RCA) and first hand analyses (FHA) was reduced to zero, with a draft version within 7 days and final report within 6 weeks on average for RCAs.

The condition of surfaces in all rooms within the radiation controlled area (RCA) of Doel 1 and 2 was recorded. A radiological evaluation was performed, based on size of defect and local dose rate, and resulting in priority levels for repair. More than 100 rooms were addressed.

For the storage of chemicals, several measures were taken in the following areas to comply with regulation and plant's expectations: storage areas for large volumes of chemical products, storage for spent chemicals and hazardous materials and the day-to-day storage areas in the workshops and labs.

The decision was taken that duty-role 3B, one of the duty-roles forming part of the emergency plan organisation, must be present at the site while on duty and has authorisation to trigger the nuclear emergency plan involving all stakeholders. This duty-role is best placed since its members have on-site radiological management and radioactive discharge as an area of knowledge.

In June 2011, Doel NPP entered into a protocol agreement with the fire department of the municipality of Beveren-Waas, covering training, dosimetry and communication aspects.

The overall conclusion is that the OSART mission has been very beneficial to Doel NPP. The issues arising from the OSART in 2010 encouraged the organization to explore and further implement best international practices. The positive result of the OSART Follow Up shows Doel NPP's commitment of towards nuclear safety.

OSART TEAM FOLLOW-UP MAIN CONCLUSIONS

The performance of the plant in addressing the findings of the OSART mission are evaluated as exemplary by the OSART follow up team. The response to all issues was based on a thorough analysis of the full scope of the problem addressed by the OSART team. As a result the corrective action programme initiated based on the plant's analysis often went well beyond the scope of the OSART recommendation and suggestions.

In case of issues which were not specific to units 1 and 2 but were applicable to the entire site, the corrective actions were implemented not only at units 1 and 2 but also at units 3 and 4. In addition the plant carefully analysed what could be done in order to achieve sustainability of the improvements. For this purpose the plant systematically addressed the work processes associated with the issues and the underlying behavioural aspects. Of course, further attention and efforts will be required to sustain the achieved improvements in the future.

Of the 15 issues identified at the OSART mission, it was evaluated by the follow-up team that 10 of these issues have been resolved, 5 issues have made satisfactory progress to date and there was no issue where insufficient progress has been made. Looking at recommendations, the resolution rate is even more favourable: four out of five recommendations were resolved. The following provides an overview of the 5 issues which have reached satisfactory progress of resolution but where some degree of further work is necessary.

In response to the suggestion concerning the condition of the cable trays and cables routed through the trays the plant has launched three major actions. First priority was assigned to improving the condition of the fire separation boards: 100% of the deficiencies were eliminated in the electrical building and about 90% of the deficiencies in the auxiliary building up to date of the follow-up mission. Adding fire retardant coating on the cables, connecting cable trays belonging to different safety system trains, was completed in one room. This activity will be continued in the period 2012-2014, depending on the decision on operating lifetime of units 1 and 2. About 1000 sections of cable trays were identified where the trays are overloaded with cables. Assessment of whether the sprinklers are sufficient for these compartments will be done in the frame of the fire hazard analysis during the period 2012-2015.

Concerning the suggestion to eliminate inadequate conditions existing in certain plant areas due to lack of attention and insufficient maintenance workmanship, the plant identified and prioritized about 19000 observations, ranging from deficiencies to useful information, on the mechanical side (on pipe flanges, hangers, supports etc.). Work on high priority (safety related) items has been started and is planned to be completed by June 2013. The plant has also initiated an ambitious plan of tagging and tracking all flange joints. Evidence of such improvements was observed by the OSART follow-up team during the field visit. Action plan for other priority items are being developed and decision on the execution of this work is expected to be taken by the end of 2012. On the electrical side around 700 deficiencies (mainly fixing of cables) were identified. All these deficiencies have been rectified.

In response to the suggestion to enhance routines for keeping the Safety Analysis Report (SAR) updated as a ‘living’ document so that it reflects the current state of the plant and site-specific hazards, the plant has significantly reduced the back-log for plant modification related changes in the SAR. More than 160 modifications were introduced in the SAR, however there is still a back-log of 10 modifications for the updating of the Final Safety Analysis Report (FSAR). During the last 18 months the plant rechecked the 214 issues covered by the second PSR. For 59 issues some adaptations in the SAR were needed. These adaptations were registered in the SAR by the end of 2011, however reflecting the situation of 1995 since they emerge from the analysis performed as part of the second PSR. This situation will be further improved because more recent data are available from the third PSR which was completely closed at the end of 2011. In agreement with BelV all subjects, including the one related to external hazard, will be implemented in the SAR by the end of October 2012.

In response to the recommendation to improve the analysis of events the plant has implemented several initiatives to enhance quality of analysis: redefinition and reinforcement of roles and responsibilities, review of all the root cause analysis reports by senior management challenge team (MT-Challenge), deletion of “Unidentifiable” as a root cause code (thereby asking investigator to specify possible future actions to arrive at the root cause). Timeliness of event investigation at the plant has shown a major improvement. Meanwhile to help the plant management with monitoring the quality of incident analysis, development of some simple performance indicators or tools would be quite beneficial. As an example one such simple indicator could be number of root cause analysis reports returned by Plant Operations Review Committee or MT-Challenge to the event investigator for improving the quality of analysis.

In response to the suggestion to improve management of hazardous chemicals the plant included a requirement for each new product to be evaluated by risk assessment to determine applicability at the plant. A new database was introduced to indicate the results of this qualification, product information, material safety data sheet, instructions and information for users. Rules of storage were clarified for large volumes of chemicals, used chemicals and ‘daily use’ (limited quantities) chemicals near the worksites. However the new rules for storage of chemicals for daily use where introduced only about 6 months before the OSART Follow up mission, and this period of time was not sufficient to achieve that the new expectations become fully embedded into the day-to-day practice. When checking randomly selected storage areas, several deviations from the established rules were observed.

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.

Plant Response/Action:

In response to the OSART suggestion, a specific action plan was drawn up aiming primarily at further reducing the number of industrial accidents and first-aid treatments of plant employees and contractors. This action plan was based on an in-depth analysis of the causes of industrial accidents and first-aid treatments in recent years and on the observations made by the OSART team.

The action plan was approved by the entire plant management team and is being implemented by all departments in close collaboration with the Internal Prevention Service.

The action plan focuses heavily on reducing possible fall, trip and bump hazards. To this end, the following measures have been taken at Doel NPP (all units):

- A specialized firm carried out a thorough screening of fall, trip and bump hazards in a part of the technical installation.
- Based on this screening, Doel NPP worked out a procedure with the standards for installing impact protection devices and signage of the relevant residual risks.
- Impact protection devices and additional signage has been installed throughout the technical installations. Residual risks have been eliminated where possible.
- Various actions have been taken to further reduce trip hazards on the site, outside the technical installations (footpaths, levelling of roads, etc.).
- To make it easier and safer to locate escape routes to emergency exits during emergencies, a large number of additional pictograms and markings have been placed on floors, walls, doors and staircases.
- An audit of the installed lighting systems was carried out by Laborelec in 2010. Subsequently, in 2010 and 2011, the vast majority of lighting fixtures at units Doel 1 and 2 were replaced with higher light-intensity equivalents and longer-life bulbs. Doel 3 and 4 are planned for 2012.

In addition, the following measures were also taken in the technical installations of Doel 1 and 2 as part of the action plan:

- To prevent electrocution risks, a full screening of the installations was carried out to detect loose grounding cables and poorly fitted cables. Most of the deficiencies detected were corrected immediately. The rest were eliminated systematically using the normal work management system.
- Cable labelling standards were clarified and incorporated into the ‘electricians notebook’ (‘*zakboekje van de elektricien*’). Also, inspection tours were carried out to identify significant deficiencies and eliminate them systematically.
- Risks associated with heavy load handling in the turbine hall have been further reduced by marking maximum allowable weight limits on several support devices, based on floor and support strength calculations. This information is also made available to enable more thorough work preparation prior to load handling.

The action plan also focuses heavily on improving safety behaviour of plant employees and contractors. Better safety behaviour leads to better safety results. Initiatives include the following:

- The Sustainable Safety Culture project was launched in 2011, in collaboration with an external company. The first step was to carry out an extensive survey among the Doel NPP personnel. Based on the findings, a targeted approach was devised. This includes specific training for all managerial staff in 2012, focused on behavioural aspects.
- The system of management task observations (around 7,000 are carried out each year) was adjusted so that the focus lies much more on paired observations, with much attention paid to safe behaviour and quality of work.

The above actions were backed up by various communication and awareness-raising campaigns.
Regular information sessions were organised for all plant employees and contractors, in which industrial safety plays a dominant role.

In addition to the above-mentioned action plan, many other measures were taken to continuously improve industrial safety. These measures form part of the Annual Action Plan (‘*Jaaractieplan’*), and are followed up periodically at the CPBW (safety committee with employer and employee representatives).

A clear improvement in safety results is found, with both the severity and frequency rates falling by an average of over 50%. For plant employees, the severity rate for industrial accidents (Tg) fell from 0.13 (end of 2009) to 0.08 (end of November 2011) and the frequency rate (Tf) from 4.14 (end of 2009) to 1.43 (end of November 2011). For contractors, the Tg fell from 0.35 at the end of 2009 to 0.17 in November 2011 and the Tf from 8.94 at the end of 2009 to 3.68 in November 2011. The number of first-aid treatments also dropped significantly.

IAEA comments:

The plant applied a systematic approach to identify the full scope of the problem associated with the industrial safety risk factors that are present and unmarked at the plant premises. This involved analysis of major causes of industrial safety accidents and minor injuries. Independent expert companies were invited to increase the plant’s sensitivity to industrial safety issues. The initiated corrective action programme based on the plant’s analysis has many facets and goes well beyond the scope of the OSART suggestion. The corrective actions are applied also at units 3 and 4, not only units 1 and 2. In order to achieve sustainability of the improvements the plant has also addressed work practices and behavioural aspects. A project of “Sustainable Safety Culture” with focus on industrial safety was initiated in 2010 with the aim to change attitude and behaviour of plant staff.

A major effort was completed in elimination or marking of falling, bumping and tripping hazards. With regard to lighting, not only deficiencies were eliminated but the entire lighting system was renewed resulting in better lighting conditions and increased lifetime of lighting devices. Risk of electrocution was reduced and handling of heavy loads was improved. The efforts resulted in a clear improvement in industrial safety performance indicators for both plant staff and contractors.

Conclusion: Issue resolved.

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.

Plant Response/Action:

In 2010, Doel NPP’s training organisation, together with the Maintenance, Engineering, Operations, Fuel and Care departments, devised the methodology and requirements for On the Job Training (OJT) applying to all services at Doel NPP. This policy was set out in the document PERS/05: Richtlijnen voor On the Job Training op Doel NPP (‘Guidelines for On the Job Training at Doel NPP’).

The document contains the following:

- Definition of OJT: all OJT leading to official certification requires a formalised approach. In all, there are 197 OJTs requiring a formal approach at Doel NPP.
- Roles, tasks and responsibilities of the persons involved in the OJT process, namely trainees, trainers, reporting superiors and members of the training organisation.
- Procedure for certification of OJT trainers.
- Uniform official template for the OJT worksheet ('specification sheet') which provides step-by-step guidance through the OJT process.
- Uniform procedure for administrative processing of OJTs.

This policy document was then translated into a concrete action plan focusing on the appointment of additional OJT trainers, the qualification of OJT trainers, the compilation of teaching materials (OJT worksheets) and implementation of the OJT process within the Doel NPP training organisation.

In accordance with the policy, the number of OJT trainers across the whole organisation has been increased from six to over 40 people.

The training for OJT trainers has been expanded and consists of two parts: traditional class training geared towards OJT, and coaching, in the field, by a manager on how to perform the task of trainer. During this coaching, the teaching skills of the OJT trainer are also tested using an observation checklist, compiled on the basis of IAEA standards. If the manager's assessment is positive, the trainer is certified to carry out formal OJT.
The training organisation keeps individual certifications in the relevant personal file.

When developing the new template for the OJT worksheet**,** particular attention was paid to:

- determining 'SMART' learning objectives, with due regard for defence-in-depth;
- preparatory steps to be taken by the trainee before embarking on OJT;
- step-by-step description of the task/action to be taught;
- monitoring of learning objectives by the trainer, line manager and training organisation officer.

In 2010 and the first half of 2011, 197 new OJT worksheets were produced (across the various departments).

The administrative tracking of OJT has been refined. Each OJT worksheet is entered into Doel NPP's official documentation system (SAP) and is given a unique code which can easily be added to the trainee's training history. Using this unique code, the training organisation tracks correct implementation of the various OJTs.

IAEA comments:

This issue has been addressed by the plant under three broad actions involving development of methodology and requirements for OJT, augmentation of the number of qualified OJT trainers and development of the training material. Policy document PERS/05, covering various aspects of OJT, has been extensively modified to reflect all the new requirements.

IAEA guidelines have been used for qualifying the new OJT trainers and the plant now has a pool of 38 trained and certified OJT trainers.

A new template for on job teaching material has been developed and formalized at the plant. Currently 206 OJT worksheets are in place. These worksheets are augmented regularly and the plant has recently developed 6 new OJT worksheets based on the experience from Fukushima accident.

Conclusion: Issue resolved

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.

Plant Response/Action:

Based on the observations made during the OSART review, a strategy document was drawn up which formed the basis for the problem analysis and subsequent approach. The strategy document details:

- the various problem scenarios;
- the characteristics, framework conditions and hypotheses of each scenario;
- the possibilities for improving the current practice;
- the supporting documents and studies.

This analysis found that various scenarios could arise in which the control room goes to closed ventilation, causing the normal fresh air supply to be cut off. These scenarios can be divided into two main groups, each of which underwent a separate detailed analysis:

- Radiological accidents where the atmosphere outside the control room is ‘breathable’, i.e. has a composition that does not pose an acute health risk, meaning that operation without personal protective equipment (PPE) is possible and the focus is on minimising the dose received.
- Toxic gas accidents where the atmosphere around the control room is ‘non-breathable’, i.e. would be immediately harmful to operators, meaning that PPE must be used.

<u>Radiological accidents</u>

A detailed calculation was made of the supply and consumption of fresh air in the different ventilation configurations. This showed that a periodic refreshment, by opening the intake of fresh air, of the atmosphere in closed ventilation under accident conditions is necessary. The chosen threshold is a too high concentration of CO_2 in the control room.
Based on extensive studies arising from the Third Periodic Safety Review of Doel 1 and 2, it can be demonstrated that the dose received by operators over the duration of the (design) accident, as a result of this periodic refreshment, remains within international acceptance criteria (according to NUREG SRP 6.4).
In summary, therefore, it can be concluded that a periodic (short-term) intake of fresh air via the ventilation system’s carbon filters, in the event of excessive CO_2 concentration, is a suitable solution to the problem identified.

The practicalities of the procedure were worked out and incorporated into existing accident procedures (Emergency Operating Procedures). To further improve the monitoring of air quality, new CO_2 meters were purchased, which enable continuous readouts in the control room during an incident. Finally, special training sessions were organised for operators to ensure complete familiarity with the procedure.

<u>Toxic gas accidents</u>

An independent analysis was carried out of the compliance of Doel 1 and 2 with the Safety Analysis Report and the applicable RG 1.78 on the existing procedures for protecting operational personnel during a toxic gas accident. This found that all requirements were met with the current number of compressed air cylinders and ABEK filters in the control room, together with the available possibilities for refilling the air cylinders on and off the site (mobile air compressors).

The existing training in correct use of compressed air cylinders and the relevant accident procedures in the event of toxic accidents were also reviewed. A number of (minor) improvements were made.

The main conclusions of the above-mentioned analysis were passed on during training for operating personnel and the relevant duty-roles.

IAEA comments:

The plant conducted a thorough analysis of habitability of the control room in different scenarios foreseen in the safety analysis report.

For accidents with radioactive releases periodic intake of fresh air to the control room was decided to be performed using CO_2 concentration as criteria to start and stop intake. The analysis has concluded that the radiation effect of this operating mode of the control room ventilation on control room operators remains within allowed limits.

For accidents when toxic gases affect the site periodic intake of fresh air to the control room was found to be not acceptable. In this situation shift personnel will use in the first phase conventional gas masks with filters and in the next phase breathing apparatus with compressed air cylinders.

A visit to the control room confirmed the availability of equipment (CO_2 concentration meter, stock of conventional gas masks with filters and breathing apparatus with compressed air cylinders), appropriate procedure changes and staff' knowledge how to use the equipment.

Conclusion: Issue resolved.

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.

Plant Response/Action:

In response to the OSART suggestion, a specific plan was drawn up to improve the condition of cable galleries in the electrical buildings of Doel 1 and 2 in terms of fire safety.

The lead in this was taken by the Care Department's Fire Safety Section, in close collaboration with the Electrical Maintenance Section and the Technical Support - Fire Section of the Maintenance Department.

The first phase involved an extensive walkdown performed by five Fire Safety Operators over a period of four months, aimed at identifying the deficiencies. The main focus was on:
- the condition of fire separation boards*;*
- cables crossing different polarities*;*
- overfull cable trays.

In total, around 3,000 deficiencies were catalogued, spread quite equally over the above three items. Cables placed outside of trays were, if possible, fitted correctly during or shortly after the walkdown.

Based on the walkdown results and analysis by the project team, a realistic action plan was then drawn up aimed at improving fire protection in the affected areas.

- Regarding the fire separation boards, it was decided to resolve all identified deficiencies (around 1,300) by fitting new boards, repairing existing boards, improving the sealing of gaps between boards, and so on. A specialized firm was brought in to carry out the work. This comprehensive remediation project began in April 2011 and will continue in 2012. The work is running to schedule, with about 1000 deficiencies resolved as at the end of November 2011.

- Regarding the cables crossing different polarities**,** it was decided to apply a special fire-retardant coating to these cables. In the first half of 2011, a suitable coating product was sought and qualified for the application in question, to ensure that no negative effects occur when the cable is operating normally. Aspects like transfer from the cable to the exterior, the impact from the additional weight, etc. were examined. A specialized firm was then qualified to carry out the work. Coating of the vertical cables began in November 2011 and will continue in 2012.

- The issue of overfull cable trays was included in the Fire Hazard Analysis (FHA) project. During the first phase of this project, implemented in 2011, an extensive walkdown was performed to chart the fire load of each compartment. In this context, a distinction was made between lightly-loaded, full and overfull cable trays. Based on the fire load present, the necessary extinguishing capacity will be later calculated for each compartment and an assessment made of whether the sprinklers present are sufficient. Based on this, the necessary changes will be initiated.

The necessary budgets have been allocated for all the above activities.

In addition to the aforementioned technical improvements, a number of organisational measures have also been implemented:

- The frequency of fire-team inspections in the cable galleries has been increased to three times a week.
- A number of additional extinguishers (CO_2, powder and CAF) have been placed at strategic points in the cable galleries.

A benchmarking study of the fire risk in the various cable galleries of the electrical buildings at Doel 1 and 2 was also carried out. This study found that the risk of fire is very low, especially in areas containing only low-voltage power and instrumentation cables. It was in these areas that most of the above-mentioned deficiencies were detected.

Moreover, an examination of the historical fire-load index shows that the fire load observed in the cable galleries is low and that no major violations have been noted in this area in recent years.

IAEA comments:

The plant completed an extensive review of the deficiencies in the condition of the cable trays and cables routed through the trays. An excel database was established with clear identification of the deficiencies. The review covered not only the cable rooms in the electrical building (GEH) but also in the auxiliary building (GNH). After the review three major actions were launched: improving the condition of the fire separation boards, adding fire retardant coating on the cables connecting cable trays of different polarities (belonging to different safety system trains) and improving the sections of cable trays where they are overloaded with cables.

First priority was assigned to improving the condition of the fire separation boards, 100% of the deficiencies were eliminated in the electrical building (GEH) and about 90% of the deficiencies in the auxiliary building (GNH) up to date of the follow-up mission.

Adding fire retardant coating on the cables connecting cable trays of different polarities was completed in one room. This allowed evaluating the scope of work and determining the work and budget resources required to complete this type of corrective actions. This activity will be continued in the period 2012-2014, depending on the decision on operating lifetime of units 1 and 2.

About 1000 sections of cable trays were identified where the trays are overloaded with cables. Walk downs to chart the fire load of compartments were completed for units 1 and 2. Assessment of whether the sprinklers are sufficient for these compartments will be done in the frame of the fire hazard analysis. This assessment is scheduled to be completed in the period 2012-2015. The necessary corrective actions will be completed after that.

Conclusion: Satisfactory progress to date.

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.

Plant Response/Action:
In response to the OSART team's findings, a specific plan was devised to substantially reduce the backlog at all units (Doel 1, 2, 3 and 4). This action plan consisted of a number of phases. The lead was taken by Maintenance, the department with the largest backlog in terms of percentage.

In phase one, the expectations regarding the work management process were tightened up. New arrangements were put in place for scheduling works, assigning priority levels to works and (where necessary) rescheduling works. The tasks and responsibilities of the various stakeholders were clarified. The clarifications and additional arrangements were incorporated into the procedure PROJ/03 *'Organisatie en planning van de dagelijkse werken'* ('Organising and scheduling daily works').

By implementing this revised procedure, a proactive effort is being made to prevent the build-up of a new backlog as well as to reduce the existing backlog in a faster and controlled manner.

An example of the latter is that a new completion date for work from the backlog can only be assigned after formal approval at the DCE (Unit Daily Coordination Meeting), attended by representatives from all departments.

Next, these changes were explained and clarified at special training given to all stakeholders in the Maintenance, Operations, Engineering and Care departments. This training was given to both work planners and line management.

The backlog tracking tool was also adapted to take account of the new arrangements. Since then, the tool has been able to select backlog based on the priority of works, in addition to the existing selection criteria. This means that it is possible to distinguish clearly between important backlog (priority 0 and 1 works) and non-important backlog (priority 2 works). Only priority 0 and 1 works entail a direct or possible risk in terms of nuclear safety, industrial safety, environment or availability.

In addition, in the Maintenance department coaches were appointed for each service. Their task was to support and guide the operational teams in reducing their existing backlog, and to ensure that PROJ/03 was properly complied with.

The actual reduction of the backlog was scheduled in two main phases.

In 2010, the focus was on reducing the entire backlog (all priorities). This approach led to a reduction of almost 50% in the total backlog for Doel 1 and 2 in the period from April 2010 to the end of 2010.

The goal for 2011 was to further eliminate the important backlog (priorities 0 and 1). This goal was achieved for priority 0 works in April 2011. By the end of November 2011, the backlog of priority 1 works at Doel 1 and 2 had been reduced by 65% from 200 to 70 items.

The impact of the entire backlog (all priorities) on nuclear safety is assessed periodically.

IAEA comments:

The plant has addressed various weaknesses in the maintenance backlog management tool which were identified during the OSART mission. History of rescheduled work orders is now maintained in the work management system SAP and methodology and responsibility for postponing the overdue work has been developed and formalized.

An elaborate system to reduce backlogs has been put in place at the plant. Backlogs have been prioritised and are being monitored at the management level on a weekly basis. An ambitious target of achieving zero back logs for the priority 0 and 1 items (top priority) was set for the year 2011 and 2012. The plant could reduce backlog in this categories by 70% and by the end of 2011 50 items were still pending. However backlog in this top priority item (priorities 0 and 1) has been brought down to 23 items at the end of February 2012 (0.1% of the total yearly workload of around 25000 items). Target for backlog in lower priority (priority 2) items which was set at 2% of the total backlog has been achieved for 2011 and has been proactively lowered to 1% of the total for 2012.

Conclusion: Issue resolved.

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.

Plant Response/Action:
In response to this suggestion, the action plan was split into a mechanical and an electrical section. Within each of these areas, the necessary actions were determined.

In the mechanical area, this OSART issue was addressed in a number of steps:

- Comprehensively map the scale of the problem.
- Draw up a plan of attack to remedy the situation.
- Start remediation work according to the established schedule.

To determine the scale of the problem, a walkdown of the entire Doel 1 and 2 installation was conducted over a six-month period by a two- to three-man team. The aim of this was to identify all flanges, hangers and supports (FHS) that did not comply with the specified criteria.

Prior to this, the criteria to be met by flanges, hangers and supports had been determined on the basis of good engineering practice. These criteria cover the following aspects, among others: desired length of bolts and studs, presence of washers, galvanic isolation between carbon steel (CS) and stainless steel, alignment/symmetry, uniformity in the way bolts/nuts are fitted, corrosion, graffiti, presence of cracks or fractures. A distinction was made between important criteria (e.g. studs too short) and less-important criteria (e.g. flange painted over).

A total of 17 buildings were inspected, equating to 685 inspected areas/rooms. In most areas, a number of deficiencies were detected, resulting in several thousands of deficiencies. Of all the deficiencies identified, 40% were classified as important.

A project team was established to begin the actual remediation work. Its initial task was to draw up a plan of attack, taking into account the prevailing standards and regulations, the availability of spare parts, practical feasibility and the need to minimise unavailabilities at the planning stage. This plan of attack also served as a guide for work planners when carrying out the actual remediation work (see below).

One key outcome was the production, in collaboration with the GDF SUEZ Group's engineering company Tractebel Engineering, of an updated 'pipe spec', based on the latest technological developments. This enables the most suitable materials to be chosen for bolts, studs, nuts and seals, according to the application.

In addition, a comprehensive roadmap was developed encompassing both technical and organisational issues and including:

- permitted FHS configurations as regards galvanic isolation, the number of free threads required for bolts, etc.;
- a tool for selecting and assessing materials, seals and flange torques according to the design characteristics of the system;
- a customised workflow/process for the planning and execution of remediation work;
- the procedure for storage and tracking of all information regarding installations on which remediation work has been carried out (e.g. use of tracking sheets).

A number of remediation jobs were then carried out in order to test and adjust the methodology developed.

In phase three, a timetable for carrying out remediation work was drawn up, taking into account the importance of the deficiencies, the specific rules/restrictions applying to each system as set out in the Technical Specifications (Safety Analysis Report), the timing of overhauls and major work, and so on. The actual remediation work began in autumn 2011 on a number of safety-related systems in the radiological controlled area.

More work is planned for 2012. The necessary resources, both financial and organisational, have been allocated for this.

In the electrical area, an extensive and systematic installation-wide walkdown of Doel 1 and 2 was carried out, based on clear expectations regarding the desired condition of cables, cable trays and cable ties. This walkdown was carried out in 2011 by a two- to three-man team. Several deficiencies were rectified immediately, others were entered into a schedule and treated subsequently. In total, around 500 deficiencies were corrected. The expectations were incorporated into the 'electrician's notebook' (see also the plant response on the issue in MOA on industrial safety).

New training modules for personnel (plant employees and contractors) were developed, with the aim of teaching and enshrining the correct procedure for all future works of this kind. The experienced acquired during the mechanical and electrical walkdowns, together with the results of various initiatives, were incorporated into these modules.

Training courses for Maintenance flange mechanics and Operations flange mechanics (for field operators) began in October 2011. The Maintenance training on the updated procedure for cables and cable ties also began in October 2011.

IAEA comments:

In view of importance of this issue and the quantity of work involved, a dedicated full time team was setup at the plant to address this issue. About 19000 observations on the mechanical side (on pipe flanges, hangers, supports etc.), ranging from deficiencies to useful information, were identified and prioritized. Rectification standards and expectations were developed to ensure consistency and quality of work.

Work on priority 1 items (40 % of the total deficiencies) has been started and is planned to be completed by June 2013. The plant has also initiated an ambitious plan of tagging and tracking all flange joints. Evidence of such improvements were observed by the OSART Follow-up team during the field visit. Action plan for other priority items are being developed and decision on the execution of this work is expected to be taken by the end of 2012.

On the electrical side around 700 deficiencies (mainly fixing of cables) were identified. All these deficiencies have been rectified.

Conclusion: Satisfactory progress to date.

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.

Plant Response/Action:
In response to the OSART recommendation, the Engineering Department's Design and Nuclear Safety Section drew up an action plan with two main components:

- updating and development of PSA models;
- development and implementation of various PSA applications.

Overall responsibility for the action plan resides with the PSA Engineer of the Design and Nuclear Safety Section.

For the updating of the existing Level 1 PSA models and the development of a Level 2 model, there was close collaboration with the GDF SUEZ Group's engineering firm Tractebel Engineering, which had developed the previous models and has extensive PSA expertise. Additional funds were made available to speed up the process. The current situation is as follows:

PSA Level 1 model for Doel 1 and 2:

- Additional shutdown modes have been added. The shutdown modes have been simulated in greater detail.

- All relevant modifications in the installation occurring between 2000 and 2010 were catalogued and subsequently integrated into the model. The new model has been available since May 2011 and reflects the situation in 2010.

PSA Level 2 model for Doel 1 and 2:

- Based on the Level 1 model for 2010, a Level 2 model has now been developed. This will be available in early 2012.

Fire PSA:

- A methodology for developing a Fire PSA model was developed in the first half of 2011. Development of the model for Doel 3 began in late 2011. A model for Doel 1 and 2 will be developed subsequently.

Periodic updating of PSA models (incorporation of installation modifications):

- In consultation with Tractebel Engineering, it was agreed to update the existing Level 1 and Level 2 models at least every five years.

Various PSA applications have been developed and/or refined and implemented at all units, in consultation with the services concerned. Some examples:

Use of the Risk Matrix:

- This application makes it possible, when planning preventive and corrective maintenance, to proactively avoid combinations of safety equipment unavailabilities which impact the Core Damage Frequency (CDF). This tool is used when compiling the weekly maintenance schedule. The practicalities (criteria, operators, etc.) are detailed in a number of procedures. This matrix has been introduced in the beginning of 2011 and has led in some instances to the replanning of safety equipment unavailabilities.

Risk Increase Factor:

- The Risk Increase Factor is the ratio between the CDF with one or more unavailabilities and the CDF with no unavailabilities. All unavailabilities that occur are evaluated using this factor on a monthly basis and the results reported periodically to the Plant Operating Review Committee (PORC). This measure was launched in mid-2011. The analysis and reporting methodology is set out in a procedure.

PSA Event Analysis:

- As of the start of 2011, events requiring an incident report are analysed using the PSA model if appropriate. The analysis and reporting methodology is set out in a procedure.

Other applications:

- Evaluation of priority level of key safety concerns
- Analysis of results of System Health Reports

There has also been additional investment in PSA training. In addition to the (existing) initial PSA training for all new recruits and refresher training for managers, all control room operators and managers with an SRO licence and Engineering managers (ca. 100 persons in total) were given specific training on the above PSA applications in 2011.

IAEA comments:

The plant has updated its PSA level 1 model and finalized its level 2 model. Both are based on the plant design as of 2010. The plant has also started to develop a fire PSA. This project is however at halt presently due to the uncertainty of continuous operations after 2015.

The updated level 1 model covers six out of seven plant operating states (POS), starting from power operation, POS A, to POS F which is the preparation for refuelling. The only POS not covered is the refuelling state POS G. The level 1 model have been extensively enhanced by the addition of previously not included initiating events, new induced events (e.g. loss of offsite power induces a reactor coolant primary pump seal LOCA), extended modelling of support systems as well as the tuning of the model based on operating experience. Based on the revised level 1 analysis the plant has initiated plant modifications and changes in operating procedures. The results from the level 2 PSA have been used to improve training of the shift crews as regards emergencies with risk of radioactive releases to the environment.

The plant has significantly improved its use of PSA in different applications. PSA is today an accepted tool in daily work. A policy note from the General Manager of the Business unit Generation, a dedicated staff at the site and a general training campaign in PSA to a large proportion of the staff have contributed significantly to this development.

Examples of today’s use of PSA:

- A Risk Matrix is used with the objective to avoid simultaneous unavailabilities which could significantly lower the safety margins.

- A Risk Increase Factor (RIF) is calculated monthly and yearly. The RIF helps to control the correct use of the Risk Matrix and point out which equipment gives the largest contribution to the overall yearly rise in core damage frequency. The RIF is one of the KPI for the plant, however, due to the short usage of RIF, the plant has to fine-tune the threshold level for this KPI in order to make it useful as a driver for improvements.

- PSA is used on a regular basis for event analysis. The objective is to make the organisation aware of the severity of an incident by a probabilistic approach.

In addition to this PSA is also used in system health reports and for long term operation analysis.

Conclusion: Issue resolved.

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.

Plant Response/Action:

Prompted by the OSART suggestion regarding the status of the Safety Analysis Report (SAR), a comprehensive package of various initiatives has resulted in a clear improvement in the status and monitoring of the SAR. Organisational descriptions of the site, issues arising from the Periodic Safety Reviews (PSRs) as well as the continual flow of modifications are incorporated faster and more accurately into the SAR.

Because the description of the organisational structure relates predominantly to the whole site (rarely to an individual unit), and often encompasses both of Electrabel's nuclear facilities (Doel and Tihange), the task of updating the relevant chapter in the various unit SARs was transferred in 2011 to ECNSD (Electrabel Corporate Nuclear Safety Department). As a corporate department, ECNSD is best placed to substantiate and account for organisational changes in the SAR. This process adjustment has resulted in a more accurate description of the organisation in the various SARs, including the reorganisation of the Engineering Department.

Regarding issues from the second periodic safety review (PSR) of Doel 1 and 2, including external hazards, an extensive exercise was carried out in 2010 to assess whether all issues arising from this completed ten-year overhaul had indeed been incorporated into the SAR. To be precise, 214 issues were evaluated with regard to their impact on the SAR. Around 10 issues were found not to have been fully incorporated into the SAR. These were processed internally by Doel NPP and Tractebel Engineering (TE). All proposed changes to the SAR were sent to Bel V for approval, mostly in the first half of 2011. Bel V is the technical support organisation of the FANC (Federal Agency for Nuclear Control). The draft SAR available at Doel NPP, which can be viewed digitally, already includes these changes. The third periodic review will be completed by the end of 2011 (see also issue 5.1(3) on PSR in Technical Support). A number of conclusions have already been implemented in the SAR, even though this was not an explicit expectation of Bel V. Further implementation in the SAR is being planned in consultation with Bel V.

The final part of this OSART suggestion related to the backlog of modifications and their impact on the SAR. By creating a dedicated fulltime five-man backlog reduction team at Doel NPP, by stepping up periodic monitoring of Doel NPP and TE project managers based on clear KPIs, and through closer collaboration with Bel V, the targets set for all units in 2011 have been achieved.

For Doel 1 and 2, in March 2010, 180 modifications had not been incorporated in the SAR in a timely fashion (including Bel V approval). By the end of November 2011, this number had been reduced by over 88% to 22. Change proposals have been submitted to Bel V for all of the outstanding 22 modifications. Consequently, the draft SAR is now fully up-to-date.

The above initiatives and measures regarding timely and correct updating of the SAR have contributed to a significant and lasting improvement in the quality of the SAR.

Doel NPP is now working steadily to further optimise the modification process and so ensure that changes to the SAR take place even more smoothly in future. Various specific measures have been taken in 2011 so that changes make their way into the SAR more quickly.

IAEA comments:

The plant is using two versions of Safety Analysis Reports, a SAR which is updated promptly by the plant, and a final SAR (FSAR) which is updated after approval of changes by the authority BelV.

By setting up a special back-log team the plant has significantly reduced the back-log for plant modification related changes in the SAR. The work of this team has resulted in a SAR which since 6 month is completely up-to-date. The work consisted of introducing more than 160 modifications in the SAR. However, there is still a back-log of 10 modifications for the updating of the FSAR. In order to, on a routine base, assure that the SAR is kept up to date the plant has changed its procedures for modifications. The new way of working implies that the adaptation of the SAR must be made before the modification can be implemented. In order to further enhance the routines the plant have continuous discussions with the authority organisation BelV, e.g. to have the draft text for the SAR included in the modification package in order to get an approval of the new text at the same time as the modification is approved; which would be in line with international best practice.

During the last 18 Month the plant rechecked the 214 issues covered by the second PSR. For 59 issues some adaptations in the SAR was needed. These adaptations were registered in the

SAR by the end of 2011, however reflecting the situation of 1995 since they emerge from the analysis performed as part of the second PSR.

As a result of this effort the plant has updated the external hazard chapter in the SAR based on one of the issues. A final approval of the new text from BelV and an updated FSAR is expected in March 2012. The information that is the basis for the update of the SAR is at least 17 years old since the document in the second PSR is dated 1995. More recent data are available, e.g. from the third PSR which was completely closed at the end of 2011. The reason why this data has not yet been used to update, for example the external hazard chapter in the SAR, is due to the fact that the plant has to obtain the final authority approval of the relevant subject in the PSR before the information can be utilized. In agreement with BelV all subjects, including the one related to external hazard, will be implemented in the SAR by the end of October 2012.

The selected facts about the differences between the organisational description in the SAR and the department procedure (REF/E/01 *Organisatie departement Engineering*) was checked and to some extent the differences still exists. For example, the responsibilities for the department head are worded differently in the two documents.

Conclusion: Satisfactory progress to date.

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.)

Plant Response/Action:

As stated in the issue summary, it was recognized by the plant and the regulator that the third Periodic Safety Review (PSR) has not been performed in a timely manner. To remedy this, organisational changes were implemented with a twofold goal:

1. Guarantee the timely ending of the current, ongoing, third Doel 1 and 2 PSR. For this PSR, an end date of 31/12/2011 was already agreed earlier with the regulator (FANC) and its technical support organisation (Bel V).
2. Guarantee that the next, fourth Doel 1 and 2 PSR gets performed along a strict planning, culminating in a final report and action plan by the agreed upon date (August 2015).

In order to obtain the first goal, it was recognized by Electrabel and Tractebel Engineering (TE) that a thorough (re)evaluation of the whole PSR project (including methodology and the progress obtained so far) was necessary. The PSR project group (with representatives of both nuclear sites Doel and Tihange, Electrabel Corporate, and TE) performed this evaluation in the first months of 2011, and presented the results of their analysis to FANC and Bel V in the course of several meetings organized in February/March 2011. In the context of these discussions, the different ongoing study subjects were categorized, and an optimal approach to arrive at closure for each ongoing subject was defined.

As a result of these discussions, Bel V also adjusted its subject closure conditions, taking into account the large amount of work that had been performed already by both nuclear sites and TE in the past years (period 2005 – 2011). It was stressed by Bel V that a necessary closure condition for an ongoing subject was the definition of a clear action plan, and the firm commitment of Doel and/or Tihange NPP to realize this action plan according to an agreed upon timing.

In the ensuing months, Doel NPP has been able to arrive at the closure of almost all of ongoing study subjects (situation on Dec 13), thanks to the roundup of the ‘question/answer-process’ with Bel V, and – in several cases – the definition of such an action plan, in which the conclusions of the studies that have been performed are translated into real and specific safety improvements. Doel NPP will be able to finish the majority (if not all) of the few remaining subjects by the end of 2011. For Doel NPP, the total number of subjects within the third PSR is 139.

In order to obtain the second goal, scope and methodology were clearly defined from the beginning (i.e. based on the IAEA Safety Guide NS-G-2.10), and a detailed planning (including holdpoints, progress presentations, and the transmission of specific documents to the Belgian safety authorities) was agreed upon with FANC and Bel V. As things stand now, there should be no problem to respect these deadlines (i.e. transmission of a global assessment report and accompanying action plan for Doel 1 and 2 by April 2015).

IAEA Comments:

The plant has successfully finalized its third PSR by the end of 2011. In a letter to the authority FANC the plant concludes that all subjects brought up in the third PSR were individually closed. The positive result was achieved by improving the process for closing subjects, monitored by a coordination group with participants from the plant, Electrabel corporate offices, Tractebel engineering, Tihange NPP and from the authority organisation BelV. The progress of the work was also monitored by a steering committee involving senior management.

In order to avoid a similar situation for the finalisation of the fourth PSR a new approach is introduced based on the IAEA NS-G-2-10. The new approach is defined in an agreement with the authority FANC and encompasses the assessment of 14 safety factors. The plant has set up a firm planning implying that the study phase shall be finalized at the end of April 2015 and that possible actions shall be implemented during a five year period thereafter.

Conclusion: Issue resolved.

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.

Plant Response/Action:
Since WANO is the first body to which nuclear power plants report incidents, the first step taken to ensure a correct solution for this suggestion was to benchmark Doel NPP with the ‘best performers’ at reporting to WANO Paris Centre (WANO PC). 72 nuclear sites are members of WANO PC, comprising a total of 144 units.

WANO PC’s minimum expectation is that each site reports at least one incident per reactor per year and does so within 20 weeks of the incident taking place. The reporting must also include a root cause analysis of the incident. In addition, WANO PC requires that a number of quality criteria are fulfilled as highly as possible (minimum score of 8 out of 10).

Doel NPP has satisfied these minimum expectations since many years, submitting four incident reports to WANO PC each year (with root cause analyses), with an average reporting time of around 15 weeks. WANO gave these incident reports an average quality rating of 9 out of 10.

The average number of incidents reported by nuclear industry to WANO PC each year is two per unit, with an average response time of 21 weeks and a quality rating of 8 out of 10.

The top 10 best performers among WANO PC's members submit an average of five incident reports a year and take on average seven weeks to do so (not necessarily the same power plants).

Based on this benchmark, and the comments of the OSART team, the management decided, with effect from July 1, 2010, to report all events for which an incident report is required at Doel NPP (this automatically includes a root cause analysis) to WANO PC, and to do so initially in a shorter time frame than had previously been the case. The target is to report to WANO PC within 10 weeks, i.e. over twice as fast as the average reporting time.

Doel NPP produces an average of around 30 incident reports per year.

If – and only if – an incident report has no added value for WANO PC, the decision may be taken not to forward it. However, this must remain an exceptional occurrence.

To achieve these objectives, the procedure for compiling incident reports for WANO PC has been adapted. The summarised incident report (translated into English) is prepared by the departmental OE manager, who is always involved in the root cause analysis, in collaboration with the lead investigator. Approval of the summarised incident report takes place via the department head, the head of OE within Process Performance Management (PPM) and finally the plant manager.

As a consequence of this new procedure, Doel NPP sent WANO PC more than 40 incident reports between July 1, 2010 and November 1, 2011, with an average reporting time of 10 weeks. Since the beginning of 2011, the average completion time has been reduced even further. WANO PC's quality criteria expectations were met.

In numerical terms, Doel NPP is in 2011 the number one reporter to WANO PC. As regards completion time, the plant is also among the better performers, certainly in relation to the number of reports submitted.

To enable better input into the IAEA's IRS database, Doel NPP also sends all its WANO external reports to Bel V, the technical support organisation of the FANC (Federal Agency for Nuclear Control). This procedure has also been in place since July 1, 2010.

Within Belgium, significant incidents are exchanged and periodically discussed with Doel's sister plant Tihange, which like Doel NPP is owned by Electrabel GDF SUEZ Group.

IAEA comments:

Before the OSART review the plant used to report 1event/ unit/year to WANO. As a result of the suggestion made by the OSART team, the plant embarked on an elaborate programme to enhance the sharing of their operating experience with the external organizations. Decision was taken by the plant management to share with WANO all the events that undergo a root cause analysis and to share them within a time limit of 10 weeks (WANO requirement is 20 weeks). Procedures and resources have been put in place to achieve these targets.

Above efforts have resulted in sharing of 33 reports with WANO during 2011 (equivalent to 8.3 events/unit/year). WANO-Paris Centre has acknowledged Doel NPP as the top contributor to their event database for 2011. For the first two months of the current year the plant has already shared 4 event with WANO.

To enhance sharing with IAE/NEA IRS database the plant has also send all the reports shared with WANO to Bel V (TSO to the regulator).

Conclusion: Issue resolved.

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.

Plant Response/Action:
On the basis of the OSART recommendation, the management of Doel NPP drew up an action plan comprising various phases. The leading player in the action plan was the Operating Experience Section within the Process Performance Management (PPM) Department.

In phase one, a benchmarking exercise was carried out with several North American power plants and the IAEA and WANO guidelines on quality of incident analysis and handling.

This exercise showed that Doel NPP's existing policy and associated procedures on Operating Experience comply with current standards. Doel NPP's distinction between Root Cause Analyses (RCAs) and First Hand Analyses (FHAs), designed to achieve the right focus while managing the workload, was also upheld. In this connection, FHAs represent both causal tree analyses and technical analyses.

This benchmark and an internal evaluation within Doel NPP showed however that the necessary improvement, as regards both quality and timeliness of analyses, had to be achieved by better enforcement of these existing procedures, expectations and training.

In the second phase, therefore, the enforcement in these areas was tightened up. This resulted in the following measures, among others:

- The role of the Plant Operating Review Committee was clarified.
- The role of the existing OE managers in the various departments was clarified and their specific tasks in terms of assisting authors to carry out RCAs and FHAs were determined.
- Each RCA must also be challenged by the relevant department head before being validated.
- For each causal tree analysis of an industrial accident (or near-miss), the Health & Safety Service provides the necessary support.
- The target deadlines for completing RCAs were made tougher: a draft version should be available within seven days and the final version within two months.
- The target deadline for completing an FHA was confirmed as three months.
- The expectations regarding quality and timeliness of analyses were refreshed to OE managers and all senior staff

To enable strict monitoring of the above target deadlines, additional performance indicators were established regarding the timeliness of RCAs (draft and final) and 'run-through times' within departments and sections.

In addition, there is weekly reporting to line management about any backlog of RCAs or FHAs, based on individual name lists.

This comprehensive approach has resulted in a significant improvement in the run-through time of RCAs and FHAs. Since September 2010, there has been no backlog in the handling of RCAs and FHAs and no backlog in the implementation of corrective actions arising from these analyses.

Between July 1, 2010 and the end of 2011, a total of 45 RCAs and 385 FHAs were carried out. In the case of RCAs, the average time taken to complete the draft version was 7 days while the final reports were completed in an average of 6 weeks. This is in line with the new objectives. The average run-through time for FHAs was 73 days, also in line with the target deadline of 3 months.

IAEA comments:

Based on the detailed review and various benchmarking exercises carried out, it was confirmed by the plant management that inadequate enforcement of existing procedures and guidelines was the main cause of this issue. To ensure adherence to the root cause analysis methodologies and develope ownership, roles and responsibilities were redefined, reinforced and included in OE guidance document ERV/01. This has resulted in department OE manager now becoming a key player in ensuring the quality and timeliness of analysis. Some other new initiatives implemented by the plant to enhance quality of analysis include: review of all the root cause analysis reports by senior management challenge team (MT-Challenge), deletion of "Unidentifiable" as a root cause code (thereby asking investigator to specify possible future actions to arrive at the root cause). The plant has recently implemented a corrective actions effectiveness review programme which will also help in enhancing the quality of the root cause analysis but will take time to produce results.

Timeliness of event investigation at the plant has shown a big improvement. Average value for completion of the draft root cause analysis reports is 6.2 days (target 7 days) and completion of the final analysis report is done in 35 days (target 61 days). Similarly, the technical analysis for lower level events (apparent cause analysis) is now completed on an average in 59 days against the target of 95 days.

Meanwhile to help the plant management with monitoring the results of these initiatives, development of some simple performance indicators/ tools would be quite beneficial. As an example one such simple indicator could be number of root cause analysis reports returned by PORC or MT-Challenge to the event investigator for improving the quality of analysis.

Conclusion: Satisfactory progress to date.

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

Safety Series No. 115 (BSS), Appendix I

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."

Plant Response/Action:
The first step taken was to examine critically the observations made during the OSART review in the light of the underlying safety concern, namely the prevention of increased individual and collective dose among personnel as the result of possible hotspots on surfaces that are difficult or impossible to decontaminate, in accordance with the ALARA principle.

The condition of surfaces in all areas/rooms within the radiation controlled area (RCA) of Doel 1 and 2 was recorded in detail by a number of employees from the Radiation Protection Section. Because the walls of these areas had already been painted during extensive painting works in 2009 and 2010 and are of less concern regarding possible hotspots, the inspection focused mainly on the condition of the floors.

The observations varied from very minor damage to areas with no epoxy on the floor surface. The outcome of this comprehensive exercise was a set of coloured diagrams for each building, storey and area/room, complete with an overview table.

Next, priority levels were assigned based on the size and location of each observation: ‘high’ or ‘low’. Also, for each observation it was determined, in collaboration with colleagues from the technical support service of Maintenance, what specific action was needed to bring the condition into line with the best standards and an estimate was made of the work hours required.

Prior to the repair works, all areas/rooms were re-measured by Radiation Protection to ascertain the maximum dose rates in each space. Based on these dose rates and the estimated number of man-hours, a radiological evaluation was performed for all observations, in which the dose that would be received during the works was weighed up against the dose that could possibly be avoided in the future. This radiological evaluation resulted in a policy document on how to approach the works. It also showed that, for a number of rooms, it was more beneficial from a radiological point of view, not to treat them.

The next stage was to draw up a schedule of works. Implementation of the actual epoxy and painting works required clear arrangements and effective collaboration between the Maintenance, Operations, Engineering, Care and Fuel departments, owing to the major impact that the works would have on scheduled fuel-handling operations, periodic carbon-filter tests and radioactivity measurements, as well as due to interference with a number of ongoing major projects.

Maintenance performed the necessary quality controls, both during and after completion of the necessary epoxy and painting works.

85% of all ‘high’ and ‘low’ priority anomalies (corresponding with more than 90 different rooms in the RCA) were addressed in 2011. The remainder will be dealt with in the beginning of 2012.

To ensure that the surfaces in the controlled area remain in good condition, all plant employees and contractors were alerted through various channels (information sessions, newsletters, etc.) about the important safety benefits of undamaged surfaces and were expressly requested to treat such surfaces with respect.

IAEA comments:

The plant has reviewed the status of floor surface coating in 385 rooms in the Radiation Controlled Area of units 1 and 2 and identified 120 deficiencies in their condition that should be repaired.

In order to follow the dose optimisation principle the plant assessed the dose which would result from each of the repair works and compared it to the expected gain in averting doses by the repair. The averted dose was estimated by such parameters as frequency of staff passing through those rooms, condition of floor coating in the room, possible impact of leak resulting in contamination and already existing ambient dose rate in that room. As a result of this optimisation it was concluded that performing the repair in 6 rooms would not be justified.

Repair work of floor coating has been performed by the time of the Follow-up mission in all of the remaining 114 rooms with a collective dose of 28 mSv. Awareness campaign was performed involving over 1200 staff members to ensure that personnel does not cause undue damage of floor coating in the future. A yearly evaluation of the good condition of the floor surface coating is guaranteed through preventive maintenance plans.

Conclusion: Issue resolved.

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

Plant Response/Action:
In response to the OSART suggestion, a specific action plan was drawn up, aimed primarily at improving the storage of chemicals at Doel NPP so as to further minimise the risk to people, the environment and the installation. This action plan was based on an in-depth analysis of the existing procedures and guidelines on product storage as well as on the observations made by the OSART team.

The action plan was approved by the plant's entire management team and is implemented by all relevant departments, in close collaboration with the Health & Safety Service, the Environmental Service, the Maintenance Section and the Chemistry Section.

The action plan distinguishes between three areas: the storage areas for large volumes of chemical products (MAZ), the storage for used chemicals and hazardous materials ('Milieuloods' WAB) and the day-to-day storage areas in the workshops, labs and so on.

The procedures and databases detailing the use and storage of products were screened and necessary changes were made. The most important procedure in this respect is PREV/07 'Beheer producten met gevaarlijke eigenschappen' ('Management of hazardous materials').

Among the measures taken were the following:

Storage area for large volumes (MAZ 286)

- Impermeable epoxy floor laid by a specialized firm.
- Metal drums no longer stored directly on the floor.
- Labels and separation rules checked against procedure PREV/07 and the necessary changes made.

Storage area for used chemicals and hazardous materials (‘Milieuloods’ WAB)

- ‘Milieuloods’ incorporated into procedure PREV/07.
- Each waste-sorting compartment in the ‘Milieuloods’ clearly identified in terms of the type of waste collected there.
- Necessary intervention equipment kept in a secured cabinet outside the waste-sorting areas.

Storage areas for day-to-day use (workshops, labs, etc.)

- List compiled of daily-use storage areas.
- Daily-use storage areas managed by the user (Maintenance, Chemistry, other), with independent inspection rounds organised by the Prevention Service.
- Inventories available in each area, listing the products present there. The Environmental Service screens these lists to check the total quantity of products present on the site.
- The technical condition of the storage cabinets was checked and a number of repairs carried out as necessary.

Chemicals allowed on the site:

- The chemical management database has been completely overhauled and the data made more accessible. The new database is called CMS, which stands for Chemical Management System.
- Generally speaking, the product names used in this database are those found on the Material Safety Data Sheets (MSDSs).
- From now on, these names will be used as standard in other related lists and documents.

The above approach on storage-area management has been backed up by various communication campaigns targeting the employees concerned.

IAEA comments:

The plant improved the process of managing hazardous chemicals. This included a requirement for each new product to be evaluated by Health and Safety, Environmental and Chemistry Services for risk assessment to determine applicability at the plant. A new database was introduced at Doel NPP and Tihange NPP to indicate the results of this qualification, product information, material safety data sheet and instructions and information for users. Rules of storage were clarified for storage of large volumes of chemicals, for the storage of used chemicals and for storage for ‘daily use’ (limited quantities) near the worksites.

Visit to storage are of large volumes (MAZ 286) and to the storage area for used chemicals and hazardous materials confirmed that the new expectations are in overall properly implemented.

However the new rules for storage of chemicals for daily use where introduced only about 6 months before the OSRT Follow up mission, and this period of time was not sufficient to achieve that the new expectations become fully embedded into the day-to-day practice. When checking randomly selected storage cabinets for daily use, several deviations form the established rules were observed:

- A container of “Neolube No. 2” produced in 2007 was found without risk pictogram, although the material safety data sheet from 2005 indicated that this material is flammable and irritating. The English text on the manufacturer’s container states that the material is “fatal when swallowed”;

- 18 spray containers were found on the lower shelf of the storage cabinets, while the suggestion is that such products should be kept on the upper shelf;

- 4 waste containers each with 250 l glycol content were found in the storage area for used chemicals. On the waste label no check box of any risk pictogram was checked. On the users info in the database and on the safety data sheet glycol is identified as irritating, so the appropriate symbol should have been “checked”.

Conclusion: Satisfactory progress to date

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.

Plant Response/Action:
In response to this recommendation, the management of the power plant decided that duty-role 3B ('wachtrol 3B'), one of the duty-roles forming part of the emergency plan organisation, must be present at the site while on duty and must have authorisation to trigger the nuclear emergency plan towards the stakeholders.

In practice this means that:

- duty-role 3B is present on site at all times, 24 hours a day, seven days a week;
- duty-role 3B is summoned to the control room by the shift operations supervisor when the latter judges that the installations are moving towards a situation where the nuclear emergency plan will need to be triggered;

- duty-role 3B informs the stakeholders (authorities) by telephone that the nuclear emergency plan is being triggered, indicating the corresponding notification level. He or she ensures that the other duty-roles are summoned and informs the off-site supporting emergency plan centres.

The management of Doel NPP deliberately opted for this system because duty-role 3B has on-site radiological management and radioactive discharge as an area of knowledge.

Given their area of knowledge, those performing duty-role 3B are very well placed to assess the seriousness of a nuclear incident and to decide whether a nuclear incident needs to be declared. This is because the notification levels are determined according to the (expected) amount of radiological discharge resulting from the technical incident.

As soon as duty-role 1, who has always had the above-mentioned authorisation, arrives on site shortly afterwards, he or she takes over full responsibility for further communicating with the authorities from duty-role 3B.

At that point, duty-role 3B assumes his/her designated responsibilities as regards radiological calculations and the provision of radiological assistance to the muster rooms.

Additional training with certification has been provided to ensure that duty-role 3B is capable of exercising this extra responsibility.

- Those performing duty-role 3B were trained to recognise the different types of design accidents based on the progression of key parameters in the control room. This knowledge was acquired during a session on the full scope simulators.
- Chapter 7 of the emergency plan manual is now mandatory reading for duty-role 3B members. This chapter describes the possible situations that require a triggering of the nuclear emergency plan and the associated notification levels.
- The duty-role members were taught who to contact by telephone and in what order.
- On a tour of the emergency plan centres, they were told which telephone lines can be used to notify the authorities if normal means of communication are unavailable.
- The new arrangements were successfully tested during an emergency plan exercise in October 2011

The above arrangements have been enshrined in the following documents:

- Emergency plan manual NP/02.
- Procedure NP/03 setting out the practical details regarding duty-roles.
- Procedure NP/06 describing the areas of knowledge and training needs of the various duty-roles, and used as the basis for compiling the annual training calendar.

IAEA Comments:

Effective from 1 October 2011 the plant has changed its emergency plan to require that Duty Role 3B (*Wachtrol 3B - WR3B*) shall be present at the site 24 hours a day and 7 days per week. The emergency plan and relevant procedures have been updated making it clear that the persons performing this duty role have the authority to autonomously classify and declare a nuclear emergency as well as to notify the proper authorities about this declaration.

The new emergency plan and relevant procedures were validated by an exercise performed at the end of October 2011. The experiences gained from the exercise have been implemented in the emergency plan and relevant procedures. The plant performs, on a yearly base, an exercise that involves also the off-site organisations. In between these larger exercises, three times per year, the plant performs exercises only involving plant staff. These four larger exercises are in turn complemented by smaller desk-top exercises.

WR3B are radiological officers and since the emergency notifications are based on real or estimated doses, deposition of certain isotopes or dose rates to the public, the radiological officers are the most suitable persons to fulfil the task to classify and declare an emergency.

The persons having the WR3B role have all gone through a full scope training session in order to be able to evaluate an event with real or anticipated radiological releases. Refresher training sessions are planned to be performed on a yearly base besides the exercises mentioned above.

Conclusion: Issue resolved.

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."

Plant Response/Action:

Doel NPP has entered into a protocol agreement with the fire department of the municipality of Beveren-Waas.

This protocol agreement covers:

- the training offered by Doel NPP to the off-site fire fighters to improve their familiarity with the installations and the rules of behaviour applying on the nuclear site;
- how to call out the public fire department from the nuclear site and how the public fire department reports external emergencies to the nuclear site;
- reception of the public fire department at the periphery of the site;
- dosimetry: when required to enter the plant's radiological controlled area, the public fire fighters will wear the electronic dosimeters issued to them by the power plant instead of their own dosimeters. Agreement was reached on the alarming levels for these dosimeters;
- the system of command during an intervention by the public fire department at the power plant.

The protocol was concluded in June 2011 between the plant manager and the mayor and fire chief of Beveren-Waas. It is valid for three years.

The protocol agreement covers all members of the Beveren-Waas fire department, both professionals and volunteers. The Beveren-Waas fire brigade is one of the largest brigades in Belgium and offers the fastest response time to the power plant site. The brigade operates from a number of fire stations, the closest situated less than 10 minutes from the power plant.

In the autumn of 2011, a number of training sessions were held at the nuclear power plant for the members of the off-site fire department.

The arrangements have been enshrined in the emergency plan manual, the Monitoring Service intervention sheets and the operational procedures of the Radiation Protection Service and the internal Fire Fighting Service.

The arrangements are practised during a yearly drill. One drill was executed in November 2011. Possible areas for improvement are discussed and enshrined.

IAEA comments:

An agreement was signed in mid June 2011 (the agreement is not dated) between the off-site fire department of the city Beveren and the plant. The city of Beveren has two fire brigade stations close to the plant, one in the city of Beveren and another in the village Kieldrecht. The agreement encompasses the following areas:

- Training. The purpose of the training is to provide to the off-site fire fighters a general overview about the nuclear process, the plant design, radiation protection as well as a familiarization with the premises of the plant. The fire fighters who are likely to be the first ones to arrive on site are given an 8 hour training. Fire fighters who are likely to come to the site as a backup are provided with a 3 hour basic training. Both categories will be given a 2 hour refresher training after two years. Any new employed fire fighter should be provided with the first basic training at a maximum of six month after his or her employment.
- How to alert the off-site fire department. The agreement provides detailed information on how the off-site fire department shall be alerted. The plant has got permission to use the national rescue radio network *Astrid* in order to be able to inform the fire fighters about the situation at the plant as they are transporting themselves to the site.
- Communications from the off-site fire department with the plant. The agreement provides detailed information on how the off-site fire department shall communicate with the plant if for example any external threat to the plant is identified, e.g. a toxic release from any nearby facility or ship.
- Prepared access routes and meeting points. The agreement has information about where and how the off-site fire fighters shall access the plant and where to meet up with plant staff.
- Dosimeter usage. The agreement contains rules on who decides which of the plant dosimeters to be used.

- Chain of command. The agreement states that the officer in command of the off-site fire fighters shall be the commanding officer for the entire fire fighting force, including the on-site fire fighters. In this role the officer shall consult with the plant responsible persons on, for example radiological hazards, what systems, components or structures to prioritize etc.

Finally the agreement has a clause on its validity, stating that it shall be evaluated and reviewed before the end of 2013.

The agreement has been validated through two exercises, one in the autumn of 2011, and one early 2012, involving both the on-site and the off-site fire departments.

As of today all off-site fire fighters, both first and second line, have taken the training stipulated in the agreement. Interviews with an officer and a fire fighter from the off-site fire department verify that the training has been effective and fulfilling its purposes. The interviews also verify that the exercises have been efficient and educational for both parties. The exercises are supervised by both internal and external observers who provide feedback based on a comprehensive checklist.

Conclusion: Issue resolved.

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.

SUMMARY OF STATUS OF RECOMMENDATIONS AND SUGGESTIONS OF THE OSART FOLLOW UP MISSION TO DOEL NPP

	RESOLVED	SATISFACTORY PROGRESS	INSUFFICIENT PROGRESS	WITH-DRAWN	TOTAL
Management, Organization & Administration	1S	-	-	- -	1S
Training and Qualification	1S	-	-	-	1S
Operations	1R -	- 1S	-	- -	1R 1S
Maintenance	1S	1S	-	-	2S
Technical Support	1R 1S	- 1S	-	-	1R 2S
Operating Experience	- 1S	1R -	-	- -	1R 1S
Radiation Protection	1S	-	-	- -	1S
Chemistry	-	1S	-	- -	1S
Emergency Planning and Preparedness	2R	-	-	- -	2R
TOTAL R (%)	80%	20%	-	-	5
TOTAL S (%)	60%	40%	-	-	10
TOTAL	67%	33%	-	-	15

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.

DEFINITIONS - FOLLOW-UP VISIT (for follow up mission)

Issue resolved - Recommendation

All necessary actions have been taken to deal with the root causes of the issue rather than to just eliminate the examples identified by the team. Management review has been carried out to ensure that actions taken have eliminated the issue. Actions have also been taken to check that it does not recur. Alternatively, the issue is no longer valid due to, for example, changes in the plant organization.

Satisfactory progress to date - Recommendation

Actions have been taken, including root cause determination, which lead to a high level of confidence that the issue will be resolved in a reasonable time frame. These actions might include budget commitments, staffing, document preparation, increased or modified training, equipment purchase etc. This category implies that the recommendation could not reasonably have been resolved prior to the follow up visit, either due to its complexity or the need for long term actions to resolve it. This category also includes recommendations which have been resolved using temporary or informal methods, or when their resolution has only recently taken place and its effectiveness has not been fully assessed.

Insufficient progress to date - Recommendation

Actions taken or planned do not lead to the conclusion that the issue will be resolved in a reasonable time frame. This category includes recommendations on which no action has been taken, unless this recommendation has been withdrawn.

Withdrawn - Recommendation

The recommendation is not appropriate due, for example, to poor or incorrect definition of the original finding or its having minimal impact on safety.

Issue resolved - Suggestion

Consideration of the suggestion has been sufficiently thorough. Action plans for improvement have been fully implemented or the plant has rejected the suggestion for reasons acceptable to the follow-up team.

Satisfactory progress to date - Suggestion

Consideration of the suggestion has been sufficiently thorough. Action plans for improvement have been developed but not yet fully implemented.

Insufficient progress to date - Suggestion

Consideration of the suggestion has not been sufficiently thorough. Additional consideration of the suggestion or the strengthening of improvement plans is necessary, as described in the IAEA comment.

Withdrawn - Suggestion

The suggestion is not appropriate due, for example, to poor or incorrect definition of the original suggestion or its having minimal impact on safety.

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
- **SSR-2/2**; Safety of Nuclear Power Plants: Operation and Commissioning (Special Safety Requirements)
- **NS-G-1.1**; Software for Computer Based Systems Important to Safety in Nuclear Power Plants (Safety Guide)
- **NS-G-2.1**; Fire Safety in the Operation of Nuclear Power Plans (Safety Guide)
- **NS-G-2.2**; Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants (Safety Guide)
- **NS-G-2.3**; Modifications to Nuclear Power Plants (Safety Guide)
- **NS-G-2.4**; The Operating Organization for Nuclear Power Plants (Safety Guide)
- **NS-G-2.5**; Core Management and Fuel Handling for Nuclear Power Plants (Safety Guide)
- **NS-G-2.6**; Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants (Safety Guide)
- **NS-G-2.7**; Radiation Protection and Radioactive Waste Management in the Operation of Nuclear Power Plants (Safety Guide)
- **NS-G-2.8**; Recruitment, Qualification and Training of Personnel for Nuclear Power Plants (Safety Guide)
- **NS-G-2.9**; Commissioning for Nuclear Power Plants (Safety Guide)
- **NS-G-2-10**; 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)
- **SSG-13**; Chemistry Programme for Water Cooled Nuclear Power Plants (Specific Safety Guide)
- **GS-R**; Part 1 Governmental, Legal and Regulatory Framework for Safety (General Safety Requirements)
- **GS-R-2**; Preparedness and Response for a Nuclear or Radiological Emergency (Safety Requirements)
- **GS-R-3**; The Management System for Facilities and Activities (Safety Requirements)
- **GS-R** Part 4; Safety Assessment for Facilities and Activities (General Safety Requirements 2009)
- **GS-G-4.1**; Format and Content of the Safety Analysis report for Nuclear Power Plants (Safety Guide 2004)
- **SSG-2**; Deterministic Safety Analysis for Nuclear Power Plants (Specific Safety Guide 2009)
- **SSG-3**; Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants (Specific Safety Guide 2010)
- **SSG-4**; Development and Application of Level 2 Probabilistic Safety Assessment for Nuclear Power Plants (Specific Safety Guide 2010)
- **GS-R Part 5**; Predisposal Management of Radioactive Waste (General Safety Requirements)
- **GS-G-2.1**; Arrangement for Preparedness for a Nuclear or Radiological Emergency (Safety Guide)
- **GSG-2**; Criteria for Use in Preparedness and Response for a Nuclear and Radiological Emergency
- **GS-G-3.1**; Application of the Management System for Facilities and Activities (Safety Guide)
- **GS-G-3.5**; The Management System for Nuclear Installations (Safety Guide)
- **RS-G-1.1**; Occupational Radiation Protection (Safety Guide)
- **RS-G-1.2**; Assessment of Occupational Exposure Due to Intakes of Radionuclides (Safety Guide)

- **RS-G-1.3**; Assessment of Occupational Exposure Due to External Sources of Radiation (Safety Guide)
- **RS-G-1.8**; Environmental and Source Monitoring for Purpose of Radiation Protection (Safety Guide)
- **SSR-5;** Disposal of Radioactive Waste (Specific Safety Requirements)
- GSG-1 Classification of Radioactive Waste (Safety Guide 2009)
- **WS-G-6.1**; Storage of Radioactive Waste (Safety Guide)
- **WS-G-2.5**; Predisposal Management of Low and Intermediate Level Radioactive Waste (Safety Guide)

▪ ***INSAG, Safety Report Series***

INSAG-4; Safety Culture

INSAG-10; Defence in Depth in Nuclear Safety

INSAG-12; Basic Safety Principles for Nuclear Power Plants, 75-INSAG-3 Rev.1

INSAG-13; Management of Operational Safety in Nuclear Power Plants

INSAG-14; Safe Management of the Operating Lifetimes of Nuclear Power Plants

INSAG-15; Key Practical Issues In Strengthening Safety Culture

INSAG-16; Maintaining Knowledge, Training and Infrastructure for Research and Development in Nuclear Safety

INSAG-17; Independence in Regulatory Decision Making

INSAG-18; Managing Change in the Nuclear Industry: The Effects on Safety

INSAG-19; Maintaining the Design Integrity of Nuclear Installations Throughout Their Operating Life

INSAG-20; Stakeholder Involvement in Nuclear Issues

INSAG-23; Improving the International System for Operating Experience Feedback

INSAG-25; A Framework for an Integrated Risk Informed Decision Making Process

Safety Report Series No.11; Developing Safety Culture in Nuclear Activities Practical Suggestions to Assist Progress

Safety Report Series No.21; Optimization of Radiation Protection in the Control of Occupational Exposure

Safety Report Series No.48; Development and Review of Plant Specific Emergency Operating Procedures

- ***Other IAEA Publications***
  - **IAEA Safety Glossary** Terminology used in nuclear safety and radiation protection 2007 Edition
  - **Services series No.12**; OSART Guidelines
  - **EPR-EXERCISE-2005**; Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency, (Updating IAEA-TECDOC-953)
  - **EPR-METHOD-2003**; Method for developing arrangements for response to a nuclear or radiological emergency, (Updating IAEA-TECDOC-953)
  - **EPR-ENATOM-2002**; Emergency Notification and Assistance Technical Operations Manual
- ***International Labour Office publications on industrial safety***
  - **ILO-OSH 2001;** Guidelines on occupational safety and health management systems (ILO guideline)
  - Safety and health in construction (ILO code of practice)
  - Safety in the use of chemicals at work (ILO code of practice)

TEAM COMPOSITION OF THE OSART MISSION

ANDERSSON Hans Olov - Sweden
Forsmarks Kraftgrupp AB
Years of nuclear experience: 30
Review area: Technical Support

ELTER Enikő - Hungary
Paks NPP
Years of nuclear experience: 16
Review area: Chemistry

FOTEDAR Suresh
IAEA
Years of nuclear experience: 35
Review area: Deputy Team Leader

FRANCIS Christopher - UK
Dungeness B Power Station,
Years of nuclear experience: 27
Review area: Operations I

GEBER Armand - France
EDF / CNPE de CIVAUX
Years of nuclear experience: 28
Review area: Management Organization and Administration

HUBER Lothar - Switzerland
Kernkraftwerk Leibstadt AG
Years of nuclear experience: 33
Review area: Maintenance

HUMPHREY Graham - Canada
Bruce Power
Years of nuclear experience: 33
Review area: Operating Experience

LAFORTUNE Jean-Francois- Canada
International Safety Research
Years of nuclear experience: 27
Review area: Emergency Planning and Preparedness

PIGOTT Edward Robert - USA
Nextera Energy Services Seabrook
Years of nuclear experience: 12
Review area: Operations II

VAMOS Gabor
IAEA
Years of nuclear experience: 33
Review area: Team Leader

VIITANEN Pekka – Finland
Olkiluoto NPP
Years of nuclear experience: 17
Review area: Radiation Protection

ZHANG Shiwei – China, PR
DAYA BAY NPP SITE Shenzhen
Years of nuclear experience: 24
Review area: Training and Qualification

OBSERVERS

CALDORO Michele
IAEA
Years of nuclear experience:4
Review area: Observer

VLCEK Jaroslav - Czech Republic
Dukovany NPP
Years of nuclear experience: 30
Review area: Observer

SARAEV Oleg- Russia
Smolensk NPP
Years of nuclear experience: 29
Review area: Observer

TEAM COMPOSITION OF THE OSART FOLLOW UP MISSION

ANDERSSON Hans Olov
Sweden
Forsmarks Kraftgrupp AB
Years of nuclear experience: 32
Review area: Technical Support, Emergency Planning and Preparedness

FOTEDAR Suresh
IAEA
Years of nuclear experience: 37
Review area: Deputy Team leader, Training and Qualifications, Maintenance, Operating Experience

VAMOS Gabor
IAEA
Years of nuclear experience: 35
Review area: Team Leader, Management Organisation and Administration, Operations, Radiation Protection, Chemistry