RESTRICTED

This Report is submitted to the Government of Belgium. Its initial distribution is restricted to the authorities concerned, the contributors to the report and responsible Agency staff. The Report will be de-restricted within 90 days of the IAEA's transmittal letter unless a contrary response has been received from the Government of Belgium.

Only when it is known that the report has been “de-restricted” should this cover sheet be removed.

Division of Nuclear Safety
International Atomic Energy Agency
P.O. Box 100
A-1400 Vienna, Austria

NSNI/OSART/07/141
ORIGINAL: English

IAEA
Atoms for Peace: The First Half Century
1957–2007

REPORT OF THE
OPERATIONAL SAFETY REVIEW TEAM
(OSART)
MISSION

TO THE

TIHANGE
NUCLEAR POWER PLANT
BELGIUM
7 to 23 May 2007

DIVISION OF NUCLEAR INSTALLATION SAFETY
OPERATIONAL SAFETY REVIEW TEAM MISSION
IAEA – NSNI/OSART/07/141

DEPARTMENT OF NUCLEAR SAFETY and SECURITY
Division of Nuclear Installation Safety

PREAMBLE

This report presents the results of the IAEA Operational Safety Review Team (OSART) review of Tihange Nuclear Power Plant, Belgium. It includes recommendations for improvements affecting operational safety for consideration by the responsible Belgium authorities and identifies good practices for consideration by other nuclear power plants. Each recommendation, suggestion, and good practice is identified by a unique number to facilitate communication and tracking.

Any use of or reference to this report that may be made by the competent Belgium organizations is solely their responsibility.

FOREWORD
by the
Director General

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

An OSART mission, carried out only at the request of the relevant Member State, is directed towards a review of items essential to operational safety. The mission can be tailored to the particular needs of a plant. A full scope review would cover eight operational areas: management, organization and administration; training and qualification; operations; maintenance; technical support; 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 judgments that were not intended would be a misinterpretation of this report.

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

CONTENT

INTRODUCTION AND MAIN CONCLUSIONS

INTRODUCTION

At the request of the Government of the Belgium, an IAEA Operational Safety Review Team (OSART) of international experts visited the site of Tihange Nuclear Power Plant and concentrated its review on the unit 1 from 7 May to 23 May 2007. Tihange NPP unit one is a part of the Tihange site which hosts all together 3 units with total capacity of 2985 MW. The Tihange NPP is part of SUEZ Group and belongs to Electrabel Company. Tihange Nuclear Power unit 1 is owned at 50% by Electrabel (EBL) and Electricity de France (EDF). The site is located on the shore of the Meuse River, approximately 30 km South-West from Liege city.

Tihange NPP operates three units Tihange 1 to 3, respectively 962 MWe, 1008 MWe, and 1015 MWe, in operation since 1975, 1983 and 1985. Unit 1 had its steam generators; reactor vessel head; control rod system; and process instrumentation system replaced. Tihange 1 is modeled on the Beaver Valley Plant in the United States. A cooling tower was added to unit 1 in 1990.

The purpose of the mission was to review operating practices in the areas of management organization and administration; training and qualifications; operations; maintenance; technical support (engineering); operating experience feedback; 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 Tihange OSART mission was the 141st in the programme, which began in 1982.

The team for Tihange unit 1 OSART was composed of experts from Brazil, Bulgaria, Canada, China, France, Germany, Romania, Russia, Slovakia, together with the IAEA staff members and three observers from Russia, Germany and the IAEA. The collective nuclear power experience of the team was approximately 344 years including the observers.

Before visiting Tihange unit 1, the team studied information provided by the IAEA and the Tihange 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 OSART team were based on Tihange's performance compared with IAEA Safety Standards and good international practices.

MAIN CONCLUSIONS

The OSART team concluded that the managers of Tihange unit 1 are committed to improving the operational safety and reliability of their plant. This is clearly demonstrated by the fact that since the OSART preparatory meeting and seminar in February 2006 Tihange plant has introduced or extended several programmes contributing to improved operational safety. During this process Tihange plant has used extensively the OSART methodology for self assessment and the IAEA Safety Standards to benchmark their existing practices and to identify useful improvements.

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

- The plant has developed an ambitious programme for reducing fire hazards in improving fire fighting capability, staff behaviour, training, fire fighting equipment and facilities;
- The plant has equipped all exits of its radiological controlled area with sensitive exit gate monitors “IPM9” that are equipped with beta and gamma detectors;
- The plant has designed and installed seismically qualified fixed structures on which blankets of lead shielding can be quickly installed and dismantled for high dose rate worksites in places where workers carry out systematic maintenance;
- A document management database was created to meet deadline requirements for essential reports (e.g. ASME), for increased precision and completeness of the issued documents, for improving operating experience (OPEX), work records and to plan future work;
- Several tools were developed to increase the behaviour of employees in charge of responding an emergency situation at the plant (specific colour-stickers for cars, blue flash light to direct rescue teams and reflex form for each key position in the emergency plan);
- The plant has set up an organization for the reception of personnel and families for managing a long accident period, in the “reception and fall-back center” in Les Awirs (Centre d’accueil et de repli des Awirs - CARA).

The team found also some areas where improvement should be done such as:

- The work authorization process and its coordination are not fully established and not always followed;
- Events are not always analyzed in a timely manner and formal root cause analysis methodology is not always used;
- The application of the human performance tools does not always meet management expectations;
- Procedures for temporary modifications, personnel operational aids and tagging are not always adhered to in a rigorous manner;
- The plant operations managers and personnel did not develop and implement a sufficiently demanding programme for resolving minor deficiencies in the field, such as labeling, cleanliness, unmanaged storage and small leakages;
- Plant workers, in some cases, do not rigorously follow the plant requirements necessary to prevent their contamination and/or spread of contamination.

Tihange unit 1 NPP management expressed a determination to address the areas identified for improvement and indicated a willingness to accept a follow-up visit in about eighteen months.

1. MANAGEMENT, ORGANIZATION AND ADMINISTRATION

1.1. ORGANIZATION AND ADMINISTRATION

Operating licenses for class-1 installations were granted to Electrabel (EBL) by Royal Decree. While the Electrabel Chief Executive Officer (CEO) holds overall responsibility for the Company, the CEO delegates responsibility for the safe operation of the plant to the site managers of Doel and Tihange. In Nuclear Safety/health physics in accordance with the Royal Decree of 20/7/01, the Electrabel CEO has set up a department which oversees the application of rules set in place to comply with regulatory measures and Nuclear Safety Regulator's "Federal Agency for Nuclear Control" (FANC) decisions. The Electrabel Health and Safety/Nuclear Safety (H&S/NS) officer ensures that the tasks of the NSH&S department are properly performed. This officer reports directly to the CEO and is assisted by the Electrabel Corporate Nuclear Safety Department (ECNSD) director and Care department managers of the plant.

The plant is organized into the Care (nuclear safety, health and safety, radiation protection and environment), Operations, Engineering support and Maintenance departments, which are cross functional. Organization, responsibilities, function and definitions are well described in detail for all departments**.** In the intranet of the site for each department organization charts are available. The Final Safety Analysis Report (FSAR) is updated with regard to changes in the organizational structure.

Responsibility and function of nuclear operation for the Electrabel corporate organization are well described. There is a clear division of responsibilities and authority interfaces between the plant and the corporate organizations. Responsibilities and interfaces are clearly understood and well described. With regard to Electrabel's support departments, the team found that they reduce the plant's workload and contribute well to enhance nuclear safety.

Corporate management monitors effectiveness of the plant management on the basis of a long term schedule. Committees such as the business oversight meeting (BO) or the independent nuclear safety committee (INSC) are in place to monitor, report and control.

There is evidence to show that the financial support provided by Electrabel (EBL) concerning safety related cost in maintenance, outages and projects is adequate when compared to international benchmarking. There is an ongoing increase in financial support, which started in 2002 and which goes up to 2009. Electrabel and the plant are encouraged to maintain the effort of the last years, even after the OSART mission to guarantee sustainable on-going success.

A long-term staffing policy and objectives for human resources are established, maintained and updated every year. The plant's staffing plan to 2012 is based on Electrabel's business plan. Objectives are adopted from Business Unit Generation (BUG) - and plant objectives. Human Resources (HR) supports the plant in providing common approaches like social relations, talent and leadership and non technical training. A general HR-policy of EBL has resulted in experienced and knowledgeable staff.

Managers and supervisors make up about 15% of the plant's staff, 15% are foreman and 70% are workers. Retention levels are very high at about 99%. Actual rotation level is about 1%.

A well planned long term succession planning is in place. In relation to the expected personnel change a reasonable overlap is planned for 2007. Staff will further increase in 2010 for new tasks and reduction of overtime hours. Examples for additional staffing are Operation (7^{th} field operator crew) and Engineering Department. There is no official corporate or plant policy currently for the temporary replacement of plant personnel. If plant staff broadens their knowledge in national, international NPPs or institutes, then Human Resources department (HR) performs a career interview six month before their return.

A well developed succession plan for critical functions with knowledge retention is established. Critical functions are defined and possible successors selected according to qualifications, their current job and their ability. Recruitment is done by HR at the request of the plant's departments. The target for 2007 is 101 new employees (14 engineers and 87 workers).

A fitness for duty policy is established and maintained as part of the plant's objectives. No drugs or alcohol tests are permitted in the plant site according Belgian law. A cross functional group gathered to react in case of evidence that rules are broken.

Under the framework of the corporate policy, the plant has defined its contractor policy. As of 1 January 2008, all contractors will need to be certified for working at the plant. Up to now nearly 1000 contractors have obtained this certification.

In Belgium there is one level of regulatory supervision, which is performed by the Federal Agency for Nuclear Control (FANC). FANC delegates some of its activities to the non-profit organization Association Vinçotte Nuclear (AVN) acting as an Authorized Inspection Organization (AIO), especially the control of the class 1 nuclear installations (nuclear power plants). This control is carried out by baseline and additional inspections, thematic or specific. The inspection reports are sent to the plant and to the FANC. Summary reports are periodically sent to the plant and to the FANC. The stations staff plan is presented to the regulator annually. Changes to the plant organization including staffing require approval by AVN.

The main interface with the regulator and its AVN inspectors is Care-NS. It controls and approves incoming and outgoing letters and reports. Direct contacts at all levels with FANC and AVN are possible without the interface with Care or the Site manager. Regular meetings are frequently held on a formal and informal base.

Management and criteria for event reporting are included in the Final Safety Analysis Report (FSAR). Thresholds and timeliness for reporting correspond to international practice. From 2004 to 2006 26 events, which were rated by the International Nuclear Event Scale (INES), were reported to AVN and FANC. 11 have been rated in INES 1. The team noted a positive and open relationship between the plant's management and AVN

The plant's external communication system is well planned and performed. Its commitment to safety is publicly declared in several publications; e.g. the brochure "Tihange Contact" or statements on environmental policies and objectives. Plans and communication protocol have been developed and implemented to ensure that communities, local politicians and government groups receive timely information on plant status and events.

Appropriate internal and external committees are established to monitor and report safety related items. Their functions and member list are clearly defined. Charters and objectives are set out in one procedure which gives support in understanding communications. The team observed a committee meeting, reviewed reports and easily followed corrective actions in the related database.

The plant is in a transition phase. The NUC 21 programmes were established at the beginning of 2000 and NUC 21+ in 2006.

The plant manages organizational changes in a formal and systematic way to review them for the safety implications. Changes are communicated to staff and stakeholders. Safety related changes in the organization or in the techniques are reported to Association Vinçotte Nuclear (AVN) or Federal Agency for Nuclear Control (FANC) on mandatory basis. The safety implementations and risks during the transition to a new position have been addressed in the application form to AVN. After the final approval by AVN in May 2006, the NUC 21+ project was started and is still ongoing. A report to assess the progress was done in February 2007 by the process and performance management (PPM) department. There was an agreement to report the experience of safety relevant organizational changes after 1 year to AVN.

Since 2003 project management training is offered by the corporate for all larger projects. It includes methodical assistance concerning change management. The plant used this tool for the OSART mission. The team encourages the plant to enforce the use of these instruments.

1.2. MANAGEMENT ACTIVITIES

At corporate level, a Global Plan for Nuclear Safety up to 2010 and a Nuclear Safety priority annual plan define the actions resulting from the strategy, the policy evolution, the status of the annual plan, the Nuclear Safety operational performance, the safety culture assessments and benchmarking results.

Management goals and objectives are developed once a year and communicated to the departments. Inputs in 2006 were the results of 8 process reviews, of the 5-year action plan and the comments of senior management.

The objectives of the Business Unit Generation (BUG) are included and cascaded down to the plant’s departments. Objectives are assigned to the appropriate departments in a formal document, presented by the site manager. The plant’s objectives are distributed during the site manager’s meeting, department meetings and section meetings. The objectives´ achievement status is performed 3 times a year. The results are communicated via site manager meetings and the tools of plants internal communication. The established goals, objectives and indicators for achievement are realistic, measurable, challenging and limited in number to prevent dilution of effort in their achievement. An “Individual Performance Agreement” (PACT) system is implemented for the contribution of individuals and groups to achieve established goals and objectives. Plant and department objectives are deployed in the form of individual performance objectives at this time for management, foremen and newly recruited personnel. They are fixed and reviewed over the year, to be used also in a financial reward system. In 2006, coordination between the parties for the agreement of personnel objectives reached a satisfying value of between 90 and 100 %. In 2007 the first coordination step has nearly been completed with 2 exceptions. However, this system is used by only 50 % of the staff. With regard to the other 50 % team objectives have been applied.

An annual self-assessment (COMPI tool) was introduced in early 2006 to evaluate the match between individual skills and job profiles. This system allows each employee to evaluate their skills according to the skills required for the position. In consultation with their line managers, employees draw up a training plan which will enable them to acquire and/or strengthen the skills necessary for the performance of their role. The team encourages the plant to apply both systems to all employees.

Management expectations are included in several documents like "Conduct of Operation" or the "Memento", which has for title "expectations in quality and nuclear safety". This well prepared booklet contains expected behaviours and values. The plant is planning to up-date the booklet on experience gained.

The plant's internal communications programme has been significantly strengthened over the past years. Routine communications to the workers are transferred via the plant's Intranet system and its 16 information terminals. This tool was used in the plant to provide information on" high pressure safety injection (HP SIS) pump" unavailability, on the OSART mission itself or on expected attitudes and behaviour. Workers interviewed were positive about the improvement in communications.

The plant's objectives state that managers must regularly go in the field to encourage good safety performance by assessing the conduct of work and the compliance with management expectations and objectives. Two monthly task observations (VOA) of nuclear safety, industrial safety and environment must be carried out by managers. The areas observed are working environment, behaviour of individuals and the processes. Reporting is done by a "fiche d'expérience"-FE. A trend analysis allows for identifying recurrent weaknesses.

The Human Performance Programme is performed by the corporate process and performance management (PPM HP) group. The group is recently set up and not yet fully staffed. The principle to enforce HP is assistance in the field and participation in analyzing the experience sheets. Additional human performance tools are established to support: safe communication, adherence to procedures, questioning attitudes, pre job briefings, task observations (VOA). The application of the Human Performance tools does not yet fully meet management expectations. The team observed obvious inconsistencies in the use of the human performance (HP) tools possibly due to recent implementation.

The team observed that pre-job briefings (PJB) is not satisfactorily applied. Management and supervisors do not sufficiently coach the employees and do not reinforce enough the strict application of the PJB-procedure. A PJB which is not properly performed may lead to a degradation of the equipment, its unavailability in the event of a demand and a decrease of nuclear safety.

The team stated a recommendation for the use of human performance (HP) tools including the application of the pre-job briefing.

The plant has implemented a number of regular meetings for information exchange and decision making. There is no daily scheduled coordination meeting between the site manager and his department managers, the Operations manager, the OPS unit managers and the shift supervisor. Shift supervisors do participate in the Operation daily meeting but do not participate in daily coordination meetings. The same information is cascaded via a chain of meetings. The team encourages the plant to analyze the chain of the daily information transmission process to improve the optimization.

Management meetings are based on fixed agenda, where nuclear safety is the priority. In the site manager's meeting an online Minutes of Meeting (MoM) is performed for use during department and section meetings. Heads of departments and sections therefore use consistent information. The team noticed the effectiveness of information. Every two weeks the site manager's meeting includes a half day plant tour.

The plant has implemented a well structured database for middle and long-term monitoring, tracking and assessing commitments and corrective actions up to their completion. The database gets input from different committees and functions such as Plant (unit) operation review committee (PORC), industrial safety, nuclear safety, environment, regulator relationship, for example. These inputs are rated on a risk matrix. The matrix is well prepared and adaptable. A forecast to actions for the next PORC is provided to follow recorded corrective actions and to check their timeliness and realization. The corrective actions in this database have had a considerable backlog in December 2006/January 2007. However, the backlog has been reduced to an acceptable quantity. When the team monitored timeliness, a substantial number of corrective actions were found being delayed. The plant is encouraged to support the drivers of the databases and take action to ensure timely solutions or to review priorities.

Experience forms (FEs) are screened once a week by process and performance management PPM HP informally and each day by the Exploitation Coordinator Manager (ECM). Additionally, they are reviewed once a month by operating experience (OE). On average 20 – 25 FE/week were written. There is also a confidential channel for FEs, which is seldom used. The plant is encouraged to analyze the cause and take corrective actions if necessary. The plant has decided to perform an HP-audit in May 2008.

The probabilistic safety analysis (PSA) is part of the plant's Periodic Safety Review. Until the end of 2006 the PSA was established and updated by Tractebel Engineering, on the behalf of the utility Electrabel, and reviewed by Association Vinçotte Nuclear (AVN). It is scheduled to finish the related PSA by 2010. The team encourages the plant to accelerate the implementation of the PSA programme to support decision making.

PSA is partially applied for the analysis of significant internal and external events, e.g. the Forsmark event in 2007 and the loss of the HP SIS in May 2007 in Tihange unit 1. Today it is not used systematically to assess plant modification and to support management decisions. The corporate body provides assistance to the power plant on risk informed management. A safety project steering committee, chaired by a senior executive of Electrabel, guides the group. The team encourages accelerating the evolution of PSA to be completed in a way to support Operational Decision Making (ODM).

1.3. MANAGEMENT OF SAFETY

The OSART team recognizes that a strong safety culture is comprised of many attributes that collectively demonstrate the maturity of the organization in that matter. The OSART team does not perform a comprehensive review of safety culture. However, during an OSART review, the team identifies many facts related to these attributes of safety culture that are provided to assist ongoing management efforts to strengthen safety culture at Tihange.

Positive features of safety culture were identified by the team as follows:

- Plant management is highly committed to improving various aspects of safety culture. Senior managers take ownership of their initiatives and they are engaged in large

projects for making positive organizational and technical changes to safety;
- Plant staff has understood the OSART mission as a learning challenge to improve safety and quality aspects;
- Plant personnel is frank, open minded and willing to learn and to correct deficiencies;
- Operational Decision Making has been successfully applied for the shutdown of unit 1 following a technical issue on safety equipment that occurs during the OSART review.

In the other hand, the following items represent features, which could be strengthened to improve the overall safety culture. The team recognizes that:
- The management expectations are comprehensive, well developed and communicated. However, management expectations are not always clearly understood yet. The staff behaviour and performance in the field do not always meet the plant expectations. For example, industrial safety rules are not always fully applied in the field;
- A procedure has been up-dated for the observation of activities by managers since April 2007. Coaching by supervisors for proper wearing of Personal Protective Equipment has been witnessed by the team as a common practice in the field. However, plant managers are not sufficiently present in the field neither to encourage, communicate, promote and coach management expectations nor to check their implementation. Although the plant has been established the new leadership and teamwork enhancement programme under the 4E concept (Ensemble, Excellence, Exemplary, Engagement), there are still areas for improvement on the leadership and teamwork;
- In the recent years, plant has made an important improvement on the labeling of structures, systems, and components. However, the team recognizes that this is still a general weak point and major efforts need to be sustained and accelerated in the area of labeling;
- The team observed that in a few cases, workers were working on equipment without formal authorization or information from the main control room. The team recognizes that rigor in working under Operation’s authorization is not systematically applied and needs improvement.

A new nuclear safety policy was issued in December 2006. The safety policy is supported by reference to safety standards, development of targets and provision of the resources necessary to achieve these targets. It is formalized in plant documents and communicated to workers in the plant’s communication tools. Targets resulting from the safety policy are incorporated in the department’s objectives and management systems.

Since 2004, the Generation Management System coordinates the operational management processes. 34 main processes are led at the Business Unit Generation (BUG) level. A general process to nuclear safety risk management has not been formalized up to now. Process owners are named and responsible for the process in the BUG. They perform a yearly process review and propose action in Site operation review committee (SORC). Below the processes, process application procedures and execution procedures are placed, which are easily accessible over the plant’s documentation system. At this time manuals for nuclear safety, industrial safety and environment safety exist. BUG plans to merge these systems with priority to nuclear safety.

A safety management system was implemented in September 2006 on the basis of the “Code interne de sureté”. The basis of the system is IAEA GS-R-3 and WENRA. The system will ensure that all elements of the different management systems are not considered separately. During the review of the industrial, environmental and QA management systems, it became clear that merging of the different quality control (QC) steps, e.g. audits of the systems, is done successfully. From the team's view this is a well-performed step.

The assessment of Safety is organized into two different control levels, where each level corresponds to the different levels of the operational hierarchical line. In this framework, two paths are scheduled. Path A is used by the operational line of the plant which has final responsibilities. Path B is used by the corporate which hierarchically and independently monitors and assesses the operational line. Both paths are connected across common meetings like site operation review committees (SORC), plant operation review committees (PORC), independent nuclear safety committees (INSC), site manager meetings and others. Both lines end by reporting to the CEO of Electrabel. Committees monitor and assess the development of nuclear safety. Senior management at the corporate and plant level is involved in the monitoring of safety performance. Audit plans exist for nuclear safety, QA, environmental topics and industrial safety. The aim is to merge these concerns in one plan by 2008. The team values the observed performance as an excellent contribution to nuclear safety.

Corporate training for management leadership has been provided since 2000. A reviewed programme is launched every two years. It includes a more generic leadership view and has not stated up to now nuclear safety as a first priority. In March 2007, the plant launched a pilot workshop to its senior management and the licensed staff. Training will be continued in September 2007, after the OSART-Mission. However, at this time there is no periodic training scheduled by the plant for Nuclear Safety. The plant is encouraged to support the performance of the mentioned training in order to strengthen nuclear safety.

Preconditions for the execution of a position in the hierarchical line are given in the Final Safety Analysis Report (FSAR). According to the FSAR, the senior managers need to have a defined experience and knowledge to manage the safe operation of power plant.

The system of licensing engineers provides new engineers with an in-depth training on plant operation. Engineers follow the same courses as control room operators and shift supervisors. About 72% of licensed engineers are not a part of the Operations Section, but their training gives them a better understanding of problems from the operations point of view, particularly in terms of nuclear safety. The team recognizes this as a good performance.

In 2004, the plant implemented a system for Operational Decision Making (ODM). Pending actions or situations are screened regarding the necessary ODM-application. ODM forms are also available over the intranet of the plant. Up to now 100 staff members have been trained in the process and its methodology. The number of applications since 2004 is increasing. This shows the acceptance of the management to apply the system. ODM could be even more effectively performed using a well developed PSA.

The plant has a set of performance indicators, which are classified on three levels. Level 1 indicators relate to strategy or management. Level 2 indicators are a tactical type. Level 3 indicators are operational and used by the departments. Levels 1 and 2 (Number 28 + 15) are reported in the plant and corporate management-meetings every three months. The process flow for definition, collection and assessment is well designed and performed. Thresholds for intervention, analysis and taking corrective actions are properly established and maintained.

Level 3 indicators are defined and collected at department level. They are reported to the site manager. Although performance indicators exist in some areas, their application, trending and use of associated targets are not consistently applied. Performance indicators, based on the departments and section management approach, are not yet finally in place all-over the site. The team has given a suggestion in this area.

1.4. QUALITY ASSURANCE PROGRAMME

A well documented QA Programme is in place at the plant that meets international standards and corresponds to Generation Management System (GMS). The responsibility, authority, structure and organizational independence of the participated departments are clearly understood. The documents include several quality control steps.

The process and performance management (PPM) schedules a periodic audit programme with expectations for nuclear safety, industrial safety, environment and quality assurance for the process view. Before these process audits, the experience of earlier audits and resulted corrective actions are observed. The programmes for 2005 – 2007 and 2007 - 2009 were reviewed relating to their comprehensiveness and performance.

Besides the audit plan of PPM, more technical audits for nuclear safety, industrial safety and environmental protection are performed by the process owners. Schedules and results are approved by the SORC.

1.5. INDUSTRIAL SAFETY AND ENVIRONMENTAL PROGRAMME

Industrial safety and environmental protection programmes are an integral part of plant management. They are supported by the corporate organization. The last industrial safety policy statement was issued in June 2006 and the last environmental policy statement was issued in December 2006. Both policies and programmes are well described and documented. The plant received OHSAS 18001 certification in July 2005 and had it renewed in July 2006; The plant received the European Eco Management Audit Scheme (EMAS) certification and had it renewed in 2006.

The Business Unit Generation (BUG) provides support with personnel and services. Changes to legal, federal or local legislation are monitored by the corporate organization and discussed every month. The results are entered in a database, which includes a register of laws and a hazard identification tool that provide support to the plant. Organization and responsibilities for industrial safety management are clearly defined in the organizational procedures. Responsibility concerning industrial safety risks lies with line management.

A review of the plant industrial safety statistics for the last five years shows a decreasing rate of lost time accidents, in comparison to the number recorded in 2003. The objective is to have no lost time accidents for personnel. At the time of the mission, 212 days had gone by without any lost-time accidents. Nevertheless, the number of contractor accidents is still too high. During the OSART mission two lost-time accidents occurred. The team followed the investigation and reporting process. Industrial safety practices observed by the team do not meet always good international practices. The plant is aware of the need to improve its industrial safety standards and has made a valiant effort. The team has stated a suggestion to plant management on this issue.

The plant implemented a policy and programme for an environmental management system in 1999, which follows the “Plan-Do-Check-Act” (PDCA) cycle. External audits are performed every 6 months and internal audits are performed once a month according to a set schedule.

Indicators of BUG are used to assess effectiveness. The programme for 2005-2007 was checked by the team to ensure it met ISO 14001 (International Standard Organization - ISO) and EMAS (European Eco Management Audit Scheme - EMAS) requirements. The team found it well coordinated with nuclear and industrial safety audits. In addition to scheduled audits, meetings are held on request if environmental objectives are jeopardized. Recorded environmental action sheets are reported to SORC. An example of Diesel oils spillages was reviewed by the team. It was found that the corrective actions could have been implemented quicker. The plant is encouraged to strengthen the system and its drivers in order to support environmental protection.

During the mission, an environmental report on results of the environmental management system for the past year and the objectives for 2007 was issued. This will be sent to the authorities of surrounding communities and will be available on the internet. The team states that the report is an excellent example of transparency and information.

1.6. DOCUMENT AND RECORDS MANAGEMENT

Documentation is a support process in the Generation management system (GMS) for the conception, updating, distribution and storage of all relevant and implemented safety related documentation. The process is well understood. Corporate Business Unit Generation (BUG) Central documentation management provides service in creation, revision and recording. Process owners are the Central documentation department. Document owners are the plant's departments. Staffing structure is well described in a corporate document. In relation to the preparation, updating, application and storage of strategic, application and execution documents, clear definitions and responsibilities are understood and described. The plant is moving towards a "paperless" process. Starting in June 2007, System Application Products-Document management system (SAP DMS) will additionally be used for easier retrieval, review and back up.

1.2. MANAGEMENT ACTIVITIES

1.2(1) Issue: The application of the human performance tools does not always meet management expectations.

The team observed obvious inconsistencies in the use of four of the five tools.

The team observed the performance of the actions during plant tours and stated the following:

– Although expectations for safe communication are included in the Memento and operational documents, the expected safe communication is not utilized due to the interpretable and contradictory description in training and information of the staff. Management does not visibly support this expectation. The provided material in the field (poster in main control room) does not support the every day use of the expected communication.

– Task observations (VOA) are not fully performed. At the time of the mission 60 % of the expected VOA was carried out. This is behind the schedule planned by the management.

– Training has been provided for a questioning attitude. Expected behavioral changes were not always observed in the field. The team gathered several facts to support this issue.

The team also observed that the pre-job briefing is not at a mature stage:

– A pre-job brief did not last an appropriate length of time on the test of auxiliary feed water pump. Only two members of the operation shift crew participated. The pre-job brief was informal according to the process of the procedure.

– The junior field operator was replaced by a deputy shift supervisor who was supposed to coach him, but the SS did not participate in the pre-job brief.

– An observed Pre-job brief to start maintenance work on replacement of two radiation detectors in a laundry did not last an appropriate length of time and did not cover all pre-defined items. Although it was a routine job, this was the first time for one of the workers to perform this task.

– During discussions with the maintenance manager it was learnt that pre-job briefs do not include operating experience (OE) inputs especially from external operating experience; It was also learnt that the guidance document on the preparation of the work packages (GDI/GPI/1004) does not contain the criteria when and what level of pre job briefs need to be conducted on a job. At present, the maintenance manager takes this decision based on his experience.

– Up to the present time, pre-job briefing (PJB) training is given to the operations and maintenance departments, but not yet to Care and engineering service (ES).

– The current procedure concerning applicable criteria for formal and non-formal PJB is not fully followed in the preparation of the task.

From the team's view this may be due to recent implementation. However, the OSART team's observations are an opportunity for management to analyze the situation and take corrective actions.

With improperly carried out human performance, the probability of degradation of safety barriers could be increased.

Recommendation: Plant management should ensure that the Human Performance tool application meets its expectations.

IAEA Basis: NS-G-2-4; 3.15: To improve human performance senior managers in each organization should understand and support the need of develop the management and technical skills of all individuals involved in plant activities to the extent necessary to perform their assigned tasks. This support should be in the form of modeling the new behaviors and providing resources including adequate funds to develop and implement management and technical skills programmes.

NS-G-2.6; 4.18: In planning activities (for MS&I), consideration should be given to potential human failures in the performance of such activities. Particular emphasis should be placed on establishing the best work procedure, providing suitable job aids …, to ensure that the potential for errors is minimized at all times.

1.3. MANAGEMENT OF SAFETY

1.3(1) Issue: Level 3 operational performance indicators and their application for use by the departments, their trending and the usage of associated targets are not consistently developed and applied.

The plant has a set of performance indicators, which are classified on three levels. Level 1 indicators relate to strategy or management. Level 2 indicators are a tactical type. Level 3 indicators are operational and used by the departments. Although level 1 and level 2 indicators are well developed and trended, the level 3 indicators are not at the same level of development.

The team found the following facts:

- Only two indicators are used to monitor the Fire Hazard on the plant: the number of fire outbreaks and the volume of fire load on the plant. There are no indicators for the reliability of Fire Protection (FP) equipment or FP staff training and exercises.
- Training performance indicators have not yet been defined in level 3.
- There is no indicator at this time for training qualification status of maintenance staff.
- No indicators for in-service- inspection (ISI) are available to date.
- Indicators to monitor pre-outage planning and outage execution are not unique with Level 1 and Level 2.
- There are no work-down curves for plant management to assess the readiness and performance of outage planning.
- Specific chemistry performance indicators developed only since 2006 and current reporting format has been established from January 2007. However, only 2 out of 10 indicators are meeting the target and are marked as green color.
- Corrective actions are indicated for performance indicators outside threshold values but trends are not analyzed as expected.
- Performance indicators are not established for some specific performance items such as laboratory instruments availability as called for by standard industry practice.

Insufficient development and use of performance indicators do not provide sufficient visibility that major plant programmes and processes, which contribute to plant safety, are being executed as planned.

Suggestion: Plant management should consider accelerating the development and the usage of level 3 operational performance indicators applied to the departments. Performance indicator trending and usage of associated targets should be considered.

IAEA Basis: NS-G-2.4; 5.20: To monitor safety performance in an effective and objective way, wherever possible and meaningful, the relevant measurable safety performance indicators should be used. These indicators should enable senior corporate management to discern and react to shortcomings and early deterioration in the performance of safety management within the train of other business performance indicators.

1.5. INDUSTRIAL SAFETY PROGRAMME

1.5(1) Issue: Industrial safety practices do not always meet plant expectations and managers and supervisors do not always consistently reinforce these expectations.

The plant has developed programmes to enhance the industrial safety of the site with regard to staff and contractors. The team observed that the escorts of the experts often corrected, on the spot, the employees' behaviour. Nevertheless, the team observed the following:

- Several persons without hearing protection were observed contrary to the displayed expectation. However, the counterpart took immediate corrective action.
- 1 person with a ponytail was observed near a rotating pump (no hairnet is required at this time).
- Beside each turbine there are rails for cranes. The empty space between the rails is not filled in or covered. This could result in tripping hazards.
- A worker was observed grinding on a pipe. The employee did not wear appropriate clothing for the task and was not wearing hearing protection. Foreman stated that he was constantly coaching staff on the same issue.
- Personnel do not wear safety glasses and not all personnel wear safety shoes where it is required by posted signs.
- Access to the safety shower in the decontamination facility is blocked (no work in progress).
- Access to some phones was hindered.
- Emergency stop button had access blocked by equipment. This appeared acceptable to maintenance personnel because it was redundant.
- Both high pressure turbines have concealed steam leaks. One has a warning sign but the other (North side) does not.
- A contractor was observed not to be wearing safety glasses while using a hammer drill. When questioned, the worker said that safety glasses are not required. Several staff including managers walked by and did not correct the situation.
- A number of missing safety boundaries in the turbine hall.
- A protective equipment list was not documented in a procedure or work permit. However, the foreman described what the practice was.
- The safety shower in room N200 is out of order. Without label. The valve is closed probably because the shower is leaking. PCT1 – SCL – Douch Sec – 19.
- There are no emergency showers installed near the battery rooms on Unit 1.
- Two safety ladders did not have any kind of safety chains or barriers. These ladders were used to go from PCT1-CVD-2V111Vv1/2/3 to the turbine hall.
- Pumping station: Unauthorized ladder fixed to C132EB1.

- A contractor was performing maintenance on the lift in the Unit 1 administrative building, covered by an annual work permit. He was found standing on the top of cabin on the top floor doing his work at a height of about 1.5 m. The lift was not disconnected from the power supply. The worker was alone and had no PPE. The Operations counterpart stopped the work in order to enquire about the particular conditions required to perform the activity. The worker closed the door from inside and descended.
- Around 20% of doors to electrical cabinets were closed but not locked**.** For instance, all doors of the electrical cabinets for the auxiliary boiler were found closed but not locked (around 15 doors).

Without following plant expectations in the field of industrial safety practices, risks of injury may increase and industrial safety performance may decrease.

Suggestion: Managers and supervisors should consider reinforcing industrial safety practices to meet plant expectations.

IAEA Basis: NS-G-2.4; 6.56: An industrial safety programme should be established and implemented to ensure that all risks to personnel involved in plant activities, in particular those activities that are safety related, kept ALARA. An industrial safety programme should be established for all personnel, suppliers and visitors, and should be refer to the industrial safety rules and practices that are to be adopted….

2. TRAINING AND QUALIFICATIONS

2.1. TRAINING POLICY AND ORGANIZATION

Based on a self-assessment in 2005, the plant established an action plan, which covered 7 items included defining a training policy, implementing a new organization, implementing a systematic approach to training (SAT), improving the evaluations, etc. Currently, the status for this action plan is being followed up regularly in the plant specific monthly meeting.

The management approved the plant training policy in 7 March 2006, posted it in meeting rooms and began to communicate it during senior staff and supervisors' meeting. The management recognizes the critical importance of staff training and development in ensuring plant safety and reliability. Only the personnel who receive appropriate training and are qualified are assigned to carry out tasks on safety or safety related equipment. The team encourages the plant to promote the training policy. This policy should be known, understood and supported by all persons concerned.

To assist the plant manager in establishing, verifying and maintaining the competence of plant staff, a new training organization was established in January 2007. This new organization consists of two parts: a local unit, the Competence and Training Center (CTC) of Electrabel Business Unit Generation (BUG), and the Operations Simulator Training service. The CTC is responsible for the implementation, monitoring, and management of all training activities for the plant departments. Each department is responsible for defining the content of their workers' initial training and retraining programmes, as well as the assessment of training effectiveness for the workers. A new position of Technical Consultant (TC) has been set up in the plant. One of the TC's tasks is to take care of staff over the age 55 who have knowledge and skills that are vital to the company. This might be a useful approach for other plants to use. The team recognizes this new organization as a major step on the way to manage turn over of personnel.

The Operations Simulator Training service is responsible for the simulator training courses. Instructors from the Operations Simulator Training service give these simulator courses to staff that are authorized to operate the plant. These courses are organized on behalf of the Operations department, which is responsible for the certification of its staff members. Simulator training is one part of the certification process of control room operators.

All initial trainings for the plant are well structured; however the approach to determining retraining programme content could be improved to ensure all training needs are met. The team strongly encourages the plant to improve the retraining programme. This programme should be formalized and based on training needs. Line management should be more involved in determining retraining content.

As part of the systematic approach to training (SAT) action plan, the plant has established competency modeling to enable the management of competencies of each individual since 2005. This modeling divides the competency into two categories, knowledge and behavioral skills, which are assigned to the job descriptions. Up to now, the plant has developed 160 competencies and 60% job descriptions, covering 80% of the plant population. Nevertheless, the team considers that this analysis is not yet complete at the plant, and lesson plans with precise training objectives in all training settings have not been developed. Further efforts are needed to continue the development of training activities in order to cover the complete SAT process. The team developed a suggestion in that area.

The training certificate records are well-organized and easy to track. Operations staff certificate records are stored in each unit, and are backed up in another unit. Other staff training records are stored in the training centre.

The Quality Assurance programme in the training area is not sufficiently developed to ensure that employees are assessed for the function they are going to perform, with the exception of the subjects set down in law. Staff just has a training certificate record if required by law. Except for this legal requirement (such as for main control room operators, welders, etc.), the plant has not set up an individual assessment process during and after each training course. Without developing during and after training for each individual, and for each training programme a training assessment against established training objectives and performance criteria, the management could not fully evaluate and certify the individual's qualification before assigning the worker to a job related to safety. The team proposed a suggestion in that area.

Yearly training plans are designed by each department and validated by the Competence and Training Center (CTC). The CTC sends the monthly schedule of registrations and lists of absentees for the previous month to each department. The team encourages the plant to decrease the numbers of absentees by taking efficient corrective actions to join the group of the best plants regarding this performance indicator.

Every year, 60 % of training activities are done by external organizations. The training organizations closely monitor the quality of external training and training effectiveness is evaluated by Tics, trainees and the CTC. This process ensures the control of the quality of training activities.

The CTC is the only group to have Training Performance Indicators (TPI). Only one basic level of assessing participant satisfaction was carried out before 2005. Now the plant is beginning to implement a 3-level training evaluation process including satisfaction feedback, an individual knowledge test and field observation.

2.2. TRAINING FACILITIES, EQUIPMENT AND MATERIAL

The plant has some training facilities on site. Most of the training facilities are located at the Competence and Training Center (CTC) on site. The CTC owns 6 classrooms equipped with blackboards, PCs, projector, etc. 1 classroom equipped with the 3 units' main control room procedures and flow sheets are available for main control room operators during training. The training center could also utilize, amongst others, the classrooms of Technifutur and Technofutur training centers that are situated not far from the plant.

There are some models, including reactor building systems and a control rod drive system, in the CTC. A training school worksite was established in the basement of the Competence and Training Center (CTC). This worksite provides an environment to simulate expectations for work performed in the plant. The team considers this as a good performance to reinforce management expectations.

The plant has a full-scope simulator available on site. This simulator is a replica of Unit 2. It can simulate the operation of the unit under various real-time operation conditions, including normal operation modes, abnormal and emergency events. The modifications and changes to the main control room are also implemented at the simulator following the plant normal maintenance process. Special experts of Electrabel deliver severe accident management training for operations personnel on a computer tool.

Extensions such as additional hardware panels, software panels and special covers have been added to the simulator in order to provide the best possible training for Unit 1 and Unit 3 operators. However, the team noticed some physical fidelity discrepancy on the simulator. The team encourages the plant to take appropriate actions to continually improve the simulator physical fidelity in order to compensate the negative training effect on the 3 units' operations staff.

Apart from the full-scope simulator, a compact simulator with an IT man-machine interface is used to illustrate specific dynamics related to regulations and physical phenomena.

Training materials including trainee manuals and handouts are available in the plant. The Competence and Training Center (CTC) organizes a training materials review meeting once a year, and has always a feedback channel from TCs and instructors. Some examples observed in the classroom show that they meet the requirements for staff learning.

2.3. QUALITY OF THE TRAINING PROGRAMMES

There are three categories of training management procedures, including a development plan, organization of training and skills management. Apart from the maintenance training procedure, there are initial training requirements for all other positions. The content of each programme incorporates the necessary knowledge and skills. The training plans for most the plant positions include periods of formal training in the classroom, on the job training, and laboratory and simulator training.

Line managers normally evaluate retraining requirements and submit them yearly to the CTC; the contents include operating experience (OPEX), plant modifications, etc.

Safety culture, industrial safety, emergency plan, fire protection and radiation protection are mandatory requirements from the plant for all staff initial training and retraining.

2.4. TRAINING PROGRAMMES FOR CONTROL ROOM OPERATORS AND SHIFT SUPERVISORS

The qualification process of shift supervisors and control room operators in the plant is different from most other countries but the content of, and time spent on, initial training, including the simulator training are similar to international practices.

The initial training programme for certified operators is in line with legal (Belgium) requirements. They follow an eighteen-month internal training course, including six weeks of training on simulators. There are four modules for main control room operators' initial training spread out over one year. They then have six months of shadow training on a shift crew. Shift supervisors are required to attend additional six-month internal shadow training.

The simulator training programme has been developed appropriately with the necessary training materials. The simulator lessons consist of a pre-briefing in the classroom and an exercise and practice on the simulator. At the end of each lesson there is a de-briefing.

The periodic retraining of shift supervisors and control room operators also meets legal requirements. It is established by the Operations Support Service and comprises the following elements: a one-week refresher course, two weeks of internal team training and two weeks of full-scope simulator training per year. Information on modifications and changes, lessons learned from the events at the plant and events from other plants are included in the two weeks of internal team training. Twice a year, operating managers, the Operations Training Service supervisor and instructors discuss the simulator retraining content.

Candidates must pass the examinations administered by a certified committee including external inspectors from the Authorized Inspection Organization (AVN). Every two years, the certifying committee does an assessment for re-certification. This re-certification is based upon a personal file listing the activities and trainings done by the candidates. Operations engineers who may at times have to replace control room operators or shift supervisors are subject to the same certification requirements.

Nevertheless, the team noticed some findings related to human behavior during the shift crew simulator retraining. The team raises a suggestion to the plant that consideration should be given to improve human behavior when conducting simulator training scenarios.

2.5. TRAINING PROGRAMMES FOR FIELD OPERATORS

The initial training for field operators is consistent and of good quality. As with certified operators, the training programme for field operators is in line with legal requirements. They follow a one-year internal training course including six months of shift shadow training. It comprises fundamental self-study; field system training with the technical consultant and additional training courses including QA, industrial safety, emergency plan, etc.

The yearly retraining programme of field operators is established by the Operations Service. The minimum four days of retraining have the following elements: legal and mandatory training and internal feedback training including operating experience (OPEX) and modifications, and some specific topics such as fire fighting exercises and evacuation of injured people.

The team evaluated that the amount of initial and retraining of field operators adequately supports job responsibilities.

2.6. TRAINING PROGRAMMES FOR MAINTENANCE PERSONNEL

The maintenance manager is responsible for the proper administrative management of the training programme for maintenance staff. The initial training for maintenance personnel is acceptable. The plant uses external companies to do training and besides, specific manufacturer training is also given.

The maintenance department has finished the individual gap analysis between the target and acquired competences, following the systematic approach to training (SAT) requirement, and established the priorities for the missing competences. A training plan for 2007 was developed and will be implemented.

2.7. TRAINING PROGRAMMES FOR TECHNICAL PLANT SUPPORT PERSONNEL

All staff members involved in technical support activities is properly trained to carry out their duties and functions. The individual training programmes are prepared for the radiation protection, chemistry and fuel handling groups. They are selected based on their preliminary professional training and work experience. Retraining needs were based on the evaluation of line managers.

New employees have an acceptable level of training and start their course with training packages and with on the job training to acquire qualification.

2.8. TRAINING PROGRAMMES FOR MANAGEMENT AND SUPERVISORY PERSONNEL

To improve the professionalism of managers' a training programme on 2 levels was developed at the plant. There are corporate training programmes aimed at different management levels and which typically last three days. These are mandatory and include retraining. Furthermore, local plant initiatives are in place, which are set up every two years: in 2007, the focus was on leadership skills and consisted of 7 ½ training days for managers and 4 ½ training days for supervisors. This year's training has emphasized in particular management presence in the field and provides 11 modules of training approaches aimed at different target groups.

2.9. TRAINING PROGRAMMES FOR TRAINING GROUP PERSONNEL

The plant has six qualified simulator instructors, two for each unit. They hold the same certificate level as shift supervisors. Before giving courses, instructors must follow an additional instructor training programme in order to be certified as simulator instructor. To maintain a direct contact with unit operations, instructors are seconded to their corresponding units during outages.

The team observed that external instructors have a high respect among the trainees and plant personnel. During the observation of the classroom training, the high quality knowledge and skills of instructors, in technical areas, instructional skills and ability to use modern training aids, was demonstrated.

2.10. GENERAL EMPLOYEE TRAINING

A dedicated general employee training (GET) programme has been designed for new employees. The GET meets the requirements of plant procedures. They include industrial safety, environment, nuclear safety, emergency plan, safety culture, quality assurance and radiation protection. The retraining frequency for training courses is also defined in the plant procedures. As an example, every five years all plant staff members take part in a refresher course on the basic rules that need to be followed in the event of a fire.

There are special training programme for the new recruited engineers provided by the parent company SUEZ. These engineers should participate in an eighteen-month training programme before their assigning to the plant, in which fundamental training, as well as PWR systems, behavioral and on the job training is provided.

Before working in the plant, subcontractors have to be certified to meet management expectations on safety culture and nuclear safety in the plant. This certification is granted if contractors pass an examination related to a four-day training course including practical exercises on the training school worksite.

DETAILED TRAINING AND QUALIFICATIONS FINDINGS

2.1. ORGANIZATION AND FUNCTIONS

2.1(1) Issue: Lesson plans with precise training objectives do not exist in all training settings.

Lesson plans are a tool to ensure that the instructor consistently covers all the steps necessary to meet training objectives.

The plant begins to apply the job competency training; however, the team noticed the following findings:

- External companies do most of maintenance training with no requirements on lesson plans.
- All on-the-job training (OJT) is without lesson plans (or field guide).
- Simulator training has descriptions of scenarios and trainee actions, but classroom training sessions just have a handout.
- All the handouts contain only general objectives instead of competency-based training objectives.

Without the effective use of lesson plans, it is difficult to ensure the consistent delivery of training from instructor to instructor and from course to course and ensure also that all required knowledge and skills are covered.

Suggestion: The plant should consider developing lesson plans with precise training objectives in all training settings.

IAEA Basis: NS-G-2.8; 4.14: Development. In this phase, training materials should be prepared so that the training objectives can be achieved.
The plant could find elements to progress in the IAEA-TECDOC-1057 (Experience in the use of systematic approach to training (SAT) for nuclear power plant personnel) and TRS380 (Nuclear Power Plant Personnel Training and its Evaluation: A Guidebook).

2.1(2) Issue: The Quality Assurance programme in the training area is not sufficiently developed to ensure that employees are assessed for the function they are going to perform, with the exception of the subjects set down in law.

Plant staff has a training certificate record if required by the legislation. Except for this legal requirement (such as for main control room operators, welders, etc.), the plant has not set up an individual assessment process during and after each training course:

- Plant staff does not systematically participate in the training which is not required by the legislation and evaluation sheets are not nominative. It is not compulsory for staff to fill out an evaluation sheet. As an example, 2 out of 50 persons on one course refused to endorse the evaluative part of the last training.
- There is no formal document for on-the-job training evaluation and no formal supporting record document.

Without developing during and after training for each individual, and for each training programme a training assessment against established training objectives and performance criteria, the management could not fully evaluate and certify the individual's qualification before assigning the worker to a job related to safety.

Suggestion: The plant should consider developing the Quality Assurance programme in the training department to ensure that employees are assessed, at the end of the training session, for the function they are going to perform.

IAEA Basis: NS-G-2.8: 3.7: The competence of each individual should be assessed against established requirements before that individual is assigned to a position. The competence of all individuals should be fully assessed periodically by various means while they perform the duties allocated to their position; the assessment should also cover the actual individual performance in the workplace. The requirements should be established in such a way as to ensure that the competences are appropriate to the tasks and activities to be performed.
4.21: All progress made in training should be assessed and documented. The means of assessing a trainee's ability include written examinations, oral questioning and performance demonstrations. A combination of written and oral examinations has been found to be the most appropriate form of demonstrating knowledge and skills. In the assessment of simulator training, pre-designed and validated observation forms and checklists should be utilized in order to increase objectivity. All assessments of simulator training sessions should include an evaluation of the trainees, the feedback given and further measures considered as a result of the evaluation. Assessment should not be regarded as a one-off activity. In some States, reassessment of individuals by instructors and their immediate supervisors is undertaken at regular intervals.

2.4. CONTROL ROOM OPERATORS AND SHIFT SUPERVISORS

2.4(1) Issue: Instructors do not fulfill entirely their role as instructors to reinforce the human behavior of operation personnel during simulator scenarios.

The team noticed the following findings during the observation of shift crew simulator retraining:

- Sometimes shift crews discuss questions without close monitoring of the plant status.
- The following observations were not corrected by the instructors:
  - A shift crew did not immediately check the safety status of the plant after a reactor trip.
  - Operators take actions with little emphasis on self-check and communication.
  - Several times operators did silence, acknowledge and reset at the same time without monitoring the alarm windows.
  - During events practice, the Shift Supervisor just read the Emergency Operating Procedure sitting down in a chair and did not do some peer checks and take care of the status of plant.
- During one post-training debriefing, the instructor did not talk about human behavior, just technical issues.

Without emphasizing good human behavior during the simulator training, risks of events during the day-to-day operation could increase.

Suggestion: The instructors should consider fulfilling their role to reinforce human behavior of operation personnel when conducting simulator training scenarios.

IAEA Basis: NS-G-2.8; 5.17: Control room operators should also be trained in plant diagnostics, control actions, administrative tasks and human factors such as attitudes and human–machine and human–human (teamwork) interfaces. Shift supervisors should additionally be trained in supervisory techniques and communication skills. Their training should, in general, be more broadly based than that of other operators.

3. OPERATIONS

3.1. ORGANIZATION AND FUNCTIONS

The Electrabel Utility has developed and implemented the company's 5-year plan from which Tihange NPP derived it's into the local plan for the current year. The operations department has established its goals in compliance with the Electrabel and Tihange NPP policies. The operations department goals are distributed through six general topics that are: operational safety, personnel, industrial safety, plant conditions, environment and processes that are supported by a set of indicators. However there is no document signed by operations department manager to demonstrate the managerial commitment to follow the policies and respective plant goals. The posted information that describes the goals has no visible corresponding information related to the respective indicators. An assigned specialist from unit 3 manages the indicators. However the indicators for unit 1 are not always available, as this process only started since the beginning of the year. A suggestion was developed in management, organization and administration (MOA) area to help the plant improving this topic.

The plant mission is supported by plant policies in the area of health and safety, environment and security and control. The further progress is reflected in respective targets and action plans.

A self-assessment at the operation department level is performed once every two months. The above mentioned set of indicators is used to trace the performance. The shifts set up their goals for the current year. These goals are clearly stated in the document known as shift action plan. Other than general goals that are in compliance with the department ones sometimes a set of specific indicators is developed and followed to cover the needs a particular shift. The self-assessment at the shift's level is performed twice a year and respective corrective measures are developed and introduced. Shift action plan documents are stored in the control room and carefully treated by shift supervisor. This self-assessment practice has been conducted since the year 2004. It is well accepted by the shift personnel and appeared to be the effective tool for performance improvement.

3.2. OPERATIONS FACILITIES AND OPERATOR AIDS

The plant has developed and implemented the system of personnel operating aids. The process is described in the procedure that has been recently introduced. There are more than 200 operational operator aids posted in the unit 1. A unit engineer is designated to follow up the operational aids. The procedure stipulates that a check-up of the operational aids is to be done twice a year. However there is no direct established link between the master procedure and the corresponding operator aid. Thus if the master procedure is changed, it is not apparent that the relevant personnel operator aid will also be changed. Apart from the newly implemented system the operator aids used in the electrical equipment area, fire protection area and in the control room are treated in different ways. The operator aids in the electrical equipment area are handled in a different way compared to the plant procedure. The field operators cannot be sure that the operator aids are all up to date. The control room operators use their own system of operator aids that do not comply with plant procedure. The team developed a recommendation in that area.

A plant procedure defines the order of handling the temporary modifications. The procedure has been recently introduced into operation. Therefore some deficiencies in the process appeared during day-to-day activities. Some temporary modifications are not treated properly and remain unknown and/or invisible or unattended. Some deviations from the procedure requirement are identified such as the cause of the modification which is not always specified. The risk assessment flow-chart (questionnaire) is not always followed properly as there is no specific criteria or supportive methods provided in the procedure to assess the importance for safety. In many cases the originator of the temporary modification bypasses the parts of risk assessment flow-chart dedicated to safety.

Several discrepancies were notices by the team in the tagging system of equipment. Incomplete information, defaults in blocking and miss use of chains could impair the quality of the tagging process. Without strictly formalized and properly followed systems of temporary modifications, of operator aids and tagging, some changes in configuration of the plant systems and equipment may generate confusion among operators. The team recommends improvements in the areas of temporary modifications, operating aids and tagging.

The control room operators are provided with the several computation tools such as a plant process computer called TCI; the “Archimed” system and a tool for controlling temperature variations in the Meuse River. The “Archimed” software independently plans load changes with optimized boron concentration values and rod position (target values suggested by the software) each time there is an up date in load (on a minute by minute basis). This software continuously optimizes tracking of axial offset, with the suggested boron concentration and control rod position value automatically readjusted on an ongoing basis according to how the situation evolves. Monitoring is done with a circular diagram indicating past axial offset values and the target to be achieved, for instance to control and stop a xenon oscillation. The link between the computer date and the calculation code used for cycle studies is guaranteed by a single and integrated computer platform. The team recognizes it as a good performance.

Some deficiencies were identified that belongs to the shutdown panel. This location is easily accessible by extended group of plant personnel with normal badge authorization and specific key. No alarm has been devised in the main control room to monitor entry to the shutdown panel. Some procedures were missing during a random check of the files with documents. There were several unattended temporary modified cables and some part of the floor in the shut down panel was damaged. Inadequate attention to provision, material and working conditions in the plant shutdown panel may decrease the shift team’s ability to operate the unit under emergency and ultimate conditions. The team developed a suggestion in this area.

The Plant diesel generators and emergency feed water pumps buildings reflect the expectations of the plant management in respect the housekeeping, cleanliness and material conditions. However some areas of the unit are still far from the level of perfection that was stated by management expectations. This may be caused by a lack of management presence in the field and insufficient attention to the coaching the field operators in performing the operational rounds. The team developed a recommendation in the chapter 3.4 of this area

3.3. OPERATING RULES AND PROCEDURES

Technical specifications are used extensively by control room and support personnel during unit operation in different operation modes. Normal operating procedures contain a requirement to make a copy of the relevant parts of a technical specification and place it into a procedure with appropriate shift personnel checks and signatures to ensure that all the requirements are properly fulfilled. However, these inserted parts of a technical specification are not pre-arranged constituents of the initial procedure. Independently the safety engineer has to check the procedure and relative technical specification requirements and put a stamp with a date and signature. On the other hand, some technical specification requirements are not clear enough and may confuse personnel and sometimes make it a challenge for them to find the requirement that needed. The team encourages the plant to review the normal operating procedures to include detailed explanations on technical specification requirement when needed.

3.4. CONDUCT OF OPERATIONS

The operators in the main control room are provided with the all-necessary procedures and lay-outs to conduct the safe operation of the unit. This includes the procedures and layouts that are to be followed during normal operation of the unit, abnormal occurrences, and emergency situations including severe accident management guidelines. The plant is in the stage of updating the set of procedures that cover the operator response to the unit alarms.

The procedures are carefully kept in the convenient space in the control room. All the procedures are accessible in the intranet however the operators use the prepared in advance legible copies. The procedures are intensively used during operator's action to control the plant equipment and system and perform surveillance tests. However some procedures are not fully tailored to the particular operating mode (normal shutdown procedure) and operators/engineers have to make online changes into in the procedure by crossing inappropriate parts. It takes time and distracts the operator from the process. On the other hand, the operators easily correct the records they make in the procedures and operating shift logs with white corrector and a pen. This demonstrates a lack of respect for the operating documentation and the team encourages the plant to improve the practice of operator records handling.

The operators keep permanent monitoring to the control room alarms using alarm response sheets that are already in use. The operations department traces the indicator concerning the number of lit annunciators and in doing so try to minimize the amount of them to as minimum as possible.

Shift turnovers are conducted in accordance with the plant procedure. During their shift relief, Main Control Room Operators (CRO) performs a tour of the control panels to check alarms. There is no other document except for logbooks to support CRO, deputy shift supervisor and field operators shift relief. When re-starting on shift after an absence, shift supervisors are provided by the operation off-shift engineer with a document that summarizes the main past events. They use this document to support their relief and during the team briefing. The team observed that there was no standardized method of conducting the team briefing, some important information was not discussed during the briefing. Some briefings were conducted by the shift supervisor so that everyone else had an opportunity to speak first, but not all. Two (2) hours passed between the beginning of relief and the end of the team briefing. The team encourages the plant to develop standardized methods for conducting shift relief and shift turnovers. One way for improvement could be to implement managers formal checking to make sure that the teams comply with plant expectations.

The main control room and shutdown panel are both easily accessible by the normal badge personnel. There is no limited list available for the plant and external personnel that are allowed to have control rooms access. An extended number of people with the dedicated badge are allowed to access the control room. Plant rule in this respect has been developed; but not yet implemented. The team has developed an issue in the chapter 3.2 of this area.

The plant is divided into the areas of management responsibility to assure that each one is under regular control and that feedback is initiated when a deficiency is identified. However the status of the areas in respect of housekeeping, labeling, and material conditions shows those management oversights are not effective enough, nor are efficient field operator's routine activities. Two field operators under the supervision of the shift supervisor are fully involved into activities related to labeling. They spend all their time identifying the missing, damaged or incorrectly positioned labels. Contractors carry out the changing of labels. However it took about a year to fulfill 1/3 of labeling task both in the primary and secondary sides. The plant target in this area is to complete the labeling by the end of the year 2007.

In accordance with their daily shift duties, the field operators (FO) perform rounds to collect the necessary data relating to equipment and system performance. At the time however, they could not devote their full attention to identifying deficiencies in the field as they were very busy with other matters. A forced outage was in progress on the unit and many infrequently performed activities had to be performed by the FOs. Nevertheless the number of FOs was the same as during normal power operations. The field operators did not pay appropriate attention to the minor deviations in the assigned areas and in doing so, showed tolerance towards the acceptance of low standards.

The team observed that the plant operations managers and personnel did not develop and implement a sufficiently demanding programme for resolving minor deficiencies in the field, such as labeling, cleanliness, unmanaged storage and small leakages. The team recommends some improvements in these areas.

The Plant has developed and introduced the procedure that is to be followed by the dedicated plant personnel in case of reactor or turbine trip. This procedure describes all the necessary actions and analysis to be performed to assure the reactor and other plant equipment and systems are in safe and proper conditions. However this procedure cannot be applied to the cases when reactor shutdown was caused by degrading plant equipment or systems conditions. The team encourages the plant to foresee necessary arrangements in this area to enhance and improve the plant behaviour in response to unplanned shutdowns caused by degrading plant conditions.

3.5. WORK AUTHORIZATIONS

Any deficiency in the plant is followed through a work request called "notification". Maintenance prepares the work clearance acceptation (WCA) before implementing the maintenance activity on the field. During this stage, maintenance and operation off-shift staff work together in order to identify the main risks and define the necessary post-maintenance tests. The industrial safety and radiation protection section must approve the WCA.

The team encourages the plant to improve the information which is provided to the on-shift shift supervisor who is responsible for delivering the work permit. Information related to the intrinsic re-qualification performed by maintenance (called "qualification" at Tihange) and also more detailed information relating to the functional re-qualification should be provided.

Shift teams issue the tagging documents for the equipment and implement them on the field. After maintenance has performed its intrinsic post-maintenance tests, the on-shift operation shift team is responsible for tagging-out, lining-up, putting into service and doing functional re-qualification of the equipment. It is mandatory to implement a double-check after tagging a 6.6 kV or 380 V component, and the team encourages the plant to extend these double checks to other tagging.

When preparing the tagging of equipment, operation decides on whether to implement or not a complementary and independent line-up of the equipment after tagging-out. Independent line-ups are not systematically implemented after tagging-out of equipment. Deferred time and independent line-ups are implemented on a monthly basis on every specific “safety line-up”, and every three months on administrative tagging and “fire safety tagging”. The team encourages the plant to extend these systematic line-ups before putting the equipment back into operation.

The work authorization process and its coordination are not fully established and not always followed. The team has recommended improvements in this area.

The operation department has developed interesting guides that provides field operators and tagging staff the description of the way to lock or un-lock every kind of 6.6kV – 380V – 220V and 115V DC breakers. These documents are displayed on the field and comply with QA requirements. They are also used for training operations new-comers. The team recognizes it as a good performance.

The process of developing procedures temporary modification before the document has been definitively modified is defined and ensures good response and good quality. Nevertheless, at unit 1 operation section there were 84 documents under revision (not including the alarm sheets). The modification of 64 out of these 84 was delayed. The team therefore developed an issue in that regard.

The process for elaborating and using temporary operating procedures was well defined and implemented. A clear and readable link exists between the affected documents (alarm sheets, periodic test procedures, etc.) and the temporary procedure and vice versa. Nevertheless there were 22 temporary operating procedures at unit 1 main control room, which is over the normal accepted average on any one unit. The team encourages the plant to decrease the number of temporary operating procedures.

Operations properly review and approve modifications. Operation sections (OP) are requested to give their opinion and analyze the impact of every forecasted modification. OPs identify the documents to be modified and the necessary training and information to provide to shift teams. The plant modification committee follows that procedures are modified within the required timescale.

One training session is provided every year to operation staff to inform them about the impact of modifications. The training covers modifications that have been implemented on unit 1 since the last training session and the ones which will be implemented during the next cycle. This training is well prepared and starts with a self-assessment questionnaire. Records of this training are kept in each operation’s staff training file. The team encourages the plant to develop individual evaluations after performing this training and to formalize the specifications and the pedagogical files to support this training. A suggestion has been developed by the TQ review area on a similar issue.

Some modifications have already been in place for several months before the realization of this training. In order to inform the shift teams in real time, this training is complemented with a “quick notification sheet" for every modification. This document is promptly provided to each shift team. It gives them a short summary of the impact of the modification. The team encourages the plant to find a formalized way of confirming that each operation team member has acquainted themselves with the content of this sheet. These sheets are also sent to the training centre. The team encourages the operation department to check that this information is properly incorporated into the training programme.

3.6. FIRE PREVENTION AND PROTECTION PROGRAMME

Fire detectors and protection equipment is maintained according to the normal plant organization for maintaining other equipment. Fire extinguisher storage zones are marked on the floor. Fire doors are also marked and generally properly closed and in good maintenance condition. Periodic controls of the integrity of fire areas are carried out by the radiation protection department. Every room is checked at least every 18 months. The fire equipment checked by the team is in good condition and tested in time. The team did not notice any deficiencies in the test labeling of fire extinguishers.

The plant has developed an ambitious programme for reducing the fire hazard. This programme is driven by plant management and produces improvements in staff behavior, training and fire fighting equipment and facilities. The plant fire committee drives the actions. The plant has developed:

- a common project with the regional fire brigade of the city close to the plant,
- main control room facilities that improve the efficiency of the operation shift team in identifying the location of a fire or emergency situation and improve the monitoring of availability of fire detection and protection equipment,

The team recognizes that as a good performance.

- a leaflet “Management of moveable fire loads”.
- a specific fire fighting training programme on simulator.

The team recognizes these developments as a good practice.

Cabinets have been specially designed to contain fire-fighting action sheets (FAI). These sheets contain information and instructions for the emergency response teams, including a fire-zoning map stating the location of the main fire fighting equipment, specific risks and hazards at the actual location (fuel oil, H2, etc.) and response procedures and instructions. They are of a good quality A3 format and plastic-covered. The large, red cabinets are easy to identify and are located in strategic locations all over the site granting access to fire zoning areas. In case of a fire or problem, the first response team members and the fire-fighters have immediate access to information relevant to their activity. They are made of plastic and therefore do not rust. They are also sealed (with a lead seal) which ensures that they are not tampered with and avoids having to open the box to check the presence of the document. The first response team members and fire-fighters have confirmed to the Tihange plant that this system of cabinets is an effective solution. The team recognizes this FAI management as a good performance.

The operation shift team effectively monitors the unavailability of fire detection and protection equipment, followed on a screen in the main control room (MCR). Nevertheless, this daily information is not used to evaluate and trend the results of fire protection (FP) risk. Unit Operation sections follow the average of consumption of limiting conditions of operation (LCOs) related to fire detection and protection equipment, however these indicators are not always reliable. The unit 1 indicator has been at “zero” since the beginning of 2007, despite the several cases of LCOs of fire detection and protection equipment during the last outage. Two indicators are used to monitor the fire hazard on the plant: the number of incipient fires and the volume of fire loads on the plant. The team encourages the plant to develop other indicators to improve the monitoring of this area.

The plant has developed close cooperation with the regional external fire fighting brigade that is located very close to the plant. The team encourages the plant to continue in this way.

The plant cannot always ensure total efficiency of the Internal Emergency Fire Fighting Team (EPI). The team encourages the plant to improve in this area.

3.7. MANAGEMENT OF ACCIDENT CONDITIONS

Clear roles and responsibilities are assigned during emergency conditions. A minimum shift group composition is defined for immediate actions.

Whilst there is no direct shift-based support from maintenance, an on-call system exists. A list of staff that is on call is available to the shift supervisor. In addition to the landline telephone system, the plant uses pagers for all on-call personnel.

Information and facilities are available to analyze severe accidents.

The full range of emergency operating procedures (EOP) is available and mainly validated on simulator and sometimes in the field before implementation. There is no formal plant requirement for systematic and formalized validation of these EOP on simulator and in the field before implementation.

Beyond design basis accident procedures have been prepared in advance to face total loss of cooling source, total loss of internal and external electric power supply, total loss of the steam generator feedwater supply and loss of the MCR with aberrant orders.

Detailed severe accident management guidelines (SAMG) have been available since 2001 and are used by the local technical support team. This team is made up of competent, well trained staff.

DETAILED OPERATIONS FINDINGS

3.2. OPERATIONS FACILITIES AND OPERATOR AIDS

3.2(1) Issue: Procedures for temporary modifications, operator aids and tagging are not always adhered to in a sufficiently rigorous manner.

During the review the team noted,

- in respect of temporary modifications that:

– The temporary modifications are handled with deviations from procedure MOD/00/10:

  - The cause of modification is not always specified (DMT1/25/07-01).
  - The risk assessment flow-chart (questionnaire) is not always followed properly (DMT1/25/07-01).
  - The affected procedures are not specified in the attachment to the modification request. There is no way to ensure that the appropriate change is introduced into the procedure and that personnel are informed.

– The definition of a temporary modification in the procedure is uncertain. No time limit is specified. Some temporary modifications have been in effect for several years.

– No criteria or supportive methods are provided in the procedure (MOD/00/10) to assess the importance for safety. In many instances, the originator of the temporary modification bypasses the parts of the risk assessment flow-chart dedicated to safety (17 out of 24).

– Temporary modification of the cable (Turbine Hall basement near EAN-1PO1VeA) is not properly carried out (No request, no identification).

– Numerous cables are disconnected from the Shutdown panel without any information.

– Temporary modification 1/26/07-05, the removed instrument is not properly fixed (left lying on the pipe).

- in respect of operator aids, an inconsistent approach is followed throughout the departments where:

– The operator aids in the electrical equipment area are handled in a way that is not in accordance with the procedure (procedure INF/GDOC/023). The field operator cannot be assured that the operator aids are all up to date.

– The operator aids in the fire protection equipment area are handled in a way that is not in accordance with procedure (INF/GDOC/023).

– The operator aids in the control room are handled in a way that is not in accordance with the procedure (procedure INF/GDOC/023). The handwritten data on operator aid #70 is corrected by the operator.

– The use of operator aids (stated in procedure INF/GDOC/023) does not allow for a direct link between the master procedure and the respective operator aid

– Room N249 pages of operator aids for the fire protection system - 1 out of 4 is not in the correct order (first page 3, then page 2, page 4 is missing).

- In MCR unit 1, behind the control panels, in the SAS3 fire detection control panel, an FAI is affixed on the glass and appeared not to be checked properly.
- An unauthorized aid is placed on the high speed transfer system "TRANSFER TRA-TRN AV TAC1/N1.
- In building E E601: an operator aid in cabinet CCCD10 for I&C current control command is not checked properly.
- In the diesel generator building there were copied pages from documentation without any authorization.
- There is unauthorized information on the borated water tank B1BI for the safety injection system (levels, angles).

▪ in respect of tagging that:

- V387iDG valve is locked with a chain and padlock but without a label. The label was removed at the end of the last outage but the chain and padlock had been forgotten.
- Room N252 Valves V2813d, V2848d, V2823d have tags (administrative safety tagging). The work clearance delivery sheet contains no indication as to whether it should be closed or opened.
- Tagging at the pumping station on fire safety equipment and nuclear safety equipment:
    - The original systems designed for blocking the V3Eb2, V4Eb2, V3Eb1 and V4Eb1 valves were found to be degraded, not maintained and unavailable. In order to lock these valves, field operators had attached very long chains to the IS fences and sometimes inside the command of the valves.
    - V277EI and V273EI valves were locked by attaching a long chain to a very small and fragile pipe.
- Unit 1 RCA 0 m, 2 chains and padlocks were used in order to lock 4 valves at the same time (but with 4 tags).

Without strictly formalized and properly followed systems of temporary modifications, of operator aids and tagging, some changes in configuration of the plant systems and equipment may generate confusion among operating personnel.

Recommendation: The plant should reinforce adherence to the procedures for temporary modifications, operator aids and tagging in a sufficiently rigorous manner**.**

IAEA Basis: DS 347 Draft 3 2007.03.01: 5.38: Operations personnel should participate in evaluations and reviews of temporary modifications prior to installation. The review should ensure that the modifications do not affect approved operational limits, do not result in a safety issue that has not been reviewed and are appropriate for the current plant configuration. After other necessary approvals have been obtained, temporary modifications should be approved by authorized operations personnel before installation. The shift supervisor should have the authority to veto any temporary modification or test according to his personal assessment.
5.39: A time limit on the installation of temporary modifications should be specified. Beyond that time the temporary modification should be reviewed again for applicability, safety and need with regard to the current plant conditions. After the review, an approval process similar to the initial approval process should be carried out if the modification is to remain installed.

5.40: Distinct tagging should be used to identify that the modification in the field is approved for use. This tagging programme should be maintained by operations personnel. Each approved modification should be assigned a unique number.

5.43: All operators should be trained to look for unapproved temporary modifications during their rounds and tours of the plant. The training should include how to identify unauthorized temporary modifications as well as the actions to be taken if such a modification is found.

6.16: An administrative control system should be established at the nuclear power plant to provide instructions on how to administer and control an effective operator aids programme, and should include at least the following:

The types of operator aids that may exist in the plant:

- The authority who is competent to review and approve operator aids before they are used.
- Assurance that operator aids contain the latest valid information.

6.17: The operator aids control system should prevent the use of unauthorized operator aids and other supportive materials such as unauthorized instructions or labels of any kind on the equipment, local panels, boards and measurement devices within the work areas.

6.18: The control system for operator aids should ensure that operator aids contain correct information, which has been reviewed and approved by a competent authority. In addition all operator aids should be reviewed periodically to determine if they are still needed, if the information in them has changed or been updated, or if they should be permanently incorporated in some manner.

7.22: The rules for electrical and mechanical isolations and radiation work permits should be published and adhered to. A qualified person from the operations department should verify isolation procedures and checklists. The tags should be periodically reviewed for accuracy and continued applicability.

7.27: Tags should be prepared by individuals who are qualified in the tagging process and are aware of the scope of work to be performed. The scope of the work should be described in sufficient detail by the organization responsible for the performance of the job. The preparation of tags should be reviewed independently for accuracy and adequacy. It is recommended that either the person preparing the tags or the person reviewing them is the formally authorized operator for the affected unit. Preferably, the tags affecting equipment important to safety should be approved by the shift supervisor or the control room operator who has the supervisory function for the affected unit.

Complimentary useful information could be found in the paragraphs 7.28, 7.29, 7.30, etc.

3.2(2) **Issue:** The current state of the plant shutdown panels in terms of necessary provisions, material and working conditions does not contribute enough to an effective shift operation in the event of main control room unavailability.

During the review the team identified:

- The normal shutdown panel is partially switched off during normal operation of the Unit. Only the ultimate shutdown panel is available.
- Two procedures (RPM-CRS1DC-1-119, I.C 099-BUR) were missing during a random document check.
- The shutdown panel is easily accessible by an extended number of plant personnel with badge authorization. There is no signal in the Main Control Room when somebody enters the shutdown panel room.
- Raw water line comes under the shutdown panel and part of the concrete floor is removed.
- The electrical penetration through the floor inside the electrical cabinet is damaged.
- A cable end in the back of the electrical cabinet is not insulated and does not carry any information.
- The cable end underneath the iron floor is not insulated and does not carry any information.
- The temperature and humidity are high and there is little air circulating. However, a plant modification (air conditioning) is in progress at the moment.

Inadequate attention to provision, material and working conditions in the plant shutdown panel may decrease the shift team's ability to operate the unit under emergency and ultimate conditions.

Suggestion: Consideration should be given to improving the overall state and necessary provisions and working conditions at the plant shutdown panel to ensure effective shift operation in the event of main control room unavailability.

IAEA Basis: DS 347 Draft 3 2007.03.01: 6.1: The facilities and equipment used by the operating staff should be well maintained and adequate to support safe and reliable operation of the plant under all operating conditions. Overall plant cleanliness, lighting and good environmental conditions are important attributes of the smooth operation of a plant and efforts should be dedicated to preserve these at a very high level.

6.7: The control room desk and panels as well as local control panels should clearly display the availability of systems and equipment. The system to designate the defective systems or equipment should allow that these are clearly indicated and properly labeled.

6.9: Instrument displays and annunciators should be unobstructed, clearly readable and understandable to the operator. The layout of work places should allow adequate control of the documents and tools used and enough space for the proper placement and use of procedures in the main control room and in in-plant working areas.

3.4. CONDUCT OF OPERATIONS

3.4(1) Issue: The plant operations managers and personnel did not develop and implement a sufficiently demanding programme for resolving minor deficiencies in the field, such as labeling, cleanliness, unmanaged storage and small leakages.

The plant is divided into the areas of management responsibility to ensure that each one is under regular control with respective feedback if a deficiency is identified. However, the status of the areas in respect of housekeeping, labeling, and material condition shows that management oversight and routine field operator activities is not effective enough.

Labeling
Many items of equipment were found without labels. Two additional field operators under the supervision of the shift supervisor are full time involved in activities related to labeling. They spend all their time identifying missing, damaged or incorrectly installed labels. Actual label refurbishment is performed by contractors. However it took a long time to complete 1/3 of labeling activities, both on the primary and secondary sides. The plant target in this area was to complete labeling by the end of 2007.

Cleanliness:

- At the entrance to the controlled area (unit 1), bags containing radioactive waste were observed; cables and wires were stored on the floor in an inappropriate place: there were no black and yellow strips painted on the ground. In addition, no indication of ownership, no indication of date, no sheet listing stored material.
- Unit 1 D301 room (emergency diesel generator), one cable tray with wires was very dirty and oily, D401 upstairs, there were two bolts at the bottom of the tank.
- Unit 1 turbine building, there were pieces of thermal insulation inside the retention device under B02VV.

Storage:

- In unit 1, room N320, access to one phone was blocked by a container.
- In the unit 1 hot shop maintenance building, access to an emergency stop button was blocked by carts.
- In the room housing emergency feedwater equipment, flanges were stored in an inappropriate place.

Unreported and accepted small leakages (oil, water, steam):

- Several oil leaks were found; some were identified while others were not. E.g. oil leak from running ventilator 1A0VhA, absorbent pad was fully soaked and oil drops on the floor, oil leak on P1Eb3 at the pump house, on 1V3EC4 and 1V3EC2 in turbine hall, on 1V200EC1 and 1V201EC1 in the turbine hall basement. Oil was leaking from two bearings of the engine of unit 1 P1PV1 which was in operation. SS did not know about these leakages. Field operator had not reported these leakages.
- Several water leaks were found in unit 1 turbine building water. Water was dripping on to telephone box 2283 from the above floor; water leak at the

pump house on EAN-1P01VhA, one leak was discovered on PCT1 EAN 2V308 and was not input as a notification. Two steam leaks in the auxiliary building S667VX and V423VX1. In the feedwater pump room on unit 1 turbine building, steam was continuously rising from the sumps. Operators considered this fact as a normal situation.

Plant management is required to perform housekeeping rounds in accordance with a plant schedule. The scope of the housekeeping rounds covers cleanliness, material condition, labeling and other deficiencies in the field. However management housekeeping rounds are not as effective as expected. In the 18^{th} week (30 April -4 May 2007), 6 out of 16 reports were completed and submitted to the responsible engineer. No standards had been established for filling out the report. No detailed information was provided.

Missing equipment labels and failure to detect or report minor equipment defects could lead to random unavailability of this equipment and increase fire risks.

Recommendation: The plant operations managers and personnel should develop and implement a demanding programme for resolving minor deficiencies in the field, such as labeling, cleanliness, unmanaged storage and small leakages.

IAEA Basis: NS-R-2; 5.17: Responsibilities and lines of communication shall clearly be set out in writing for situations in which the operating personnel discover that the status or conditions of plant systems or equipment are not in accordance with operating procedures.

3.5. WORK AUTHORIZATIONS

3.5(1) Issue: The work authorization process and its coordination are not fully established and not always followed.

Adequate authorization and information was not always obtained from operations and the RP section; key tagging points were not checked by the work supervisor; adequate and sufficient preliminary direct communication did not always take place between maintenance and operation shift teams:

- Procedure MAINT/GT/017 described maintenance work which could be performed by using a yearly work permit. This procedure was not clear enough in the definition of which work could be done by using a yearly permit and some risky activities are performed on equipment by using this kind of permit. For instance, it was authorized to lubricate rotating machines without formally notifying the control room (MCR). The only requirement was to informally notify the MCR if this activity was performed on 6.6kV equipment.
- Although the plant has defined its overall process for delivering maintenance work permits, this description contains some incomprehensible and inconsistent items. Work supervisors did not always comply with the requirements and several situations were observed where workers were working on equipment without any formal authorization or information from the main control room.
- In the unit 1 turbine hall, two workers were performing hot work without work permit or other permit. Operation team was not informed.
- In the Auxiliary Feed Water pump room, a worker had removed the insulation of a tank (B02Vv) without a WP. The escort explained that a work permit (WP) was not needed, as it was simple preparatory work.
- A work permit for cleaning activities was issued for the year on equipment which is in service.
- In MCR unit 1, just behind the control panels, two workers were drilling holes in a wall. The location of the equipment to be installed was situated just above an electrical cabinet related to a safety-related sensor (US Primary level sensors). They were working without any formal authorization from the MCR.
- A MCR operator received a phone call during shift briefing: one work supervisor asked him to turn on lighting in an electrical building. The SS told this worker to come to the MCR and show his work order (WCA). He came to MCR and it was found that he had no WCA that was required to perform its activity.
- One work permit for affixing labels was found in the field. It was neither signed by the contractor, nor corrected by the relevant person from operations and it was approved by the Operations shift supervisor.
- Before starting their work, Maintenance work supervisors did not always ensure they had adequate isolation and protection.
- No radiation work permit is used at the plant. As a substitute, radiation protection actions were included in the work order planning process. Operations personnel, chemistry and even solid radioactive waste management staff bypassed the work order (WCA) phase. They considered this to be a routine operation. Handling of Solid rad-waste or contaminated equipment

with a dose rate exceeding 2 mSv/h, without a permit being issued by SRP personnel and without specific training being delivered, is not consistent with the approach of WCA planning. Four work orders from the last T1 outage were randomly picked from records and checked for RP compliance. Three of the four WCAs had not been signed by the SRP technician. The RP clearing process had been skipped and these jobs were done without assistance from radiation personnel.

- SS did not attend the daily coordination meeting (DCM), attended by the operations and maintenance managers. He is not officially required to attend this meeting. It was stated that at the end of one DCM meeting, there were differences between Maintenance priorities and Operations priorities. There was no re-formulation of these priorities at the end the meeting and the attendees were not aware of this discrepancy. After the DCM meeting, the information given to SS by the OP participant was not in accordance with Maintenance priorities. During the daily coordination meeting, report from OPS contained same information like discussed in the meeting. It could be given also by the SS.
- SS often expressed their need to have regular contacts with maintenance representatives during their shift, especially in the early morning before the DCM meeting. They sometimes had to reinforce this expectation to maintenance staff when having no contacts with them for several days. The requirement for maintenance to have these periodic contacts with shift teams has not been included in plant or operations policy.
- WCA and maintenance work packages were given to afternoon duty SS for analysis. Work permits were approved and isolations performed during the night. There were only short periods of time and few opportunities for the OP shift team to meet maintenance planners and work supervisors in order to get more information on risk analysis and necessary post-maintenance tests. Around 10% of the daily WCA requests were not approved by SS for various reasons, including a lack of information inside the work package.

Performing work on equipment without proper work authorization and coordination between departments can lead to severe personnel injury and damage to equipment.

Recommendation: The work authorization process and its coordination should be fully established and strictly followed.

The plant should enhance its expectations and improve relevant maintenance practices to ensure the activities in the field are performed in compliance with requirements governing work authorization, adequate coordination between organizational units (maintenance, operations, radiation protection) and distribution of responsibilities.

IAEA Basis: NS-G-2.4; 6.28: Operations by shift crew. Regardless of the extent of automation of the plant, the final decisions and resulting final responsibilities of the operation should rest with plant operating staff. The operating organization of a site, therefore, should establish shift crews for continuity of the responsibilities in the tasks of plant operation. Examples of tasks or activities to be executed by a shift crew include, but are not limited to, the following:
(1) For normal operation:
- to issue work permits and prepare working conditions by isolation of

structures, systems or components or modification of their configurations.
– to cancel work permits and restore normal plant conditions by returning structures, systems or components into service or into normal configurations.

NS-G-2.6; 4.26

The factors to be taken into account in developing administrative controls and procedures applicable to maintenance, surveillance and in-service-inspection (MS&I) should include, but are not limited to, the following:

– the use of work order authorizations.
– the use of work permits in connection with equipment isolation.
– radiation protection of personnel.
– industrial safety controls.
– fire hazard controls.
– general risk assessment.
– the use of interlocks and keys.

4.27: In developing these administrative controls and procedures, account should be taken of the interfaces between each activity and other activities such as maintenance on other systems or components, plant operation and radiation protection. In particular, the following aspects should be explicitly covered:

(a) The delineation of responsibilities between those persons performing MS&I and those directly responsible for plant operation. This should not be taken as diminishing or delegating prime responsibility for safety, which rests with the personnel in charge of operations (for example, the shift supervisor).

(b) Ensuring that the operating personnel have adequate information about the plant status at all times during MS&I activities.

(c) Establishment of a work permit system controlling the issuing and cancellation of appropriate documentation such as work authorizations, equipment isolation work permits, live testing authorizations and limitations to access. This includes the designation of persons in the operating shift who are authorized to issue such permits to those responsible for carrying out MS&I work.

3.6. FIRE PREVENTION AND PROTECTION PROGRAMME

3.6(a) Good practice: The plant has developed an ambitious programme for reducing fire hazards and improving fire fighting capability. This programme is driven by plant management and has produced improvements in staff behaviour, training, fire fighting equipment and facilities:

– The plant has developed a specific fire fighting training programme on simulator.

As part of the plant's ongoing initiative to minimize the impact of an event, such as smoke release, self-ignition or an incipient fire, on plant safety, the plant has developed a specific fire fighting training programme on simulator. This training includes various stages starting with theory and ending with practical fire fighting exercises.

The plant uses a simulator at its training centre to improve staff preparation for practical exercises. This simple, mobile, flexible system provides training in proper work practices and the use of appropriate equipment in a broad range of situations simulated on a wide screen.

The simulator is managed by a specific computer programme made up of a screen displaying the situation, a touch-sensitive pad on which the trainee stands and a bank of extinguishers equipped with sensors. The simulator accurately reproduces the development or control of the fire on the basis of the trainees' actions, for instance selection and use of a type of extinguisher, distance from flames, etc.

This simulator has improved the efficiency of this training, thanks to:

- Numerous scenarios and quick development: more content in less time.
- Simulates near-real conditions without the related disadvantages: no need to create a fire and therefore no pollution, less stress for the trainees, who are more receptive to information as a result.
- Easy to implement: centralizes training resources at the plant, significantly reduces cost and effort of traveling (time wasted, fatigue, transport risks, pollution).

– The plant has published a leaflet: "Management of moveable fire loads".

The leaflet provides information and tips in a handy format which is accessible to all workers, setting out the basic moveable fire load management principles, with a few chosen illustrations.

It defines the products concerned and the rules for storage outside warehouses, the use of a fire-proof cabinet and temporary storage. One section shows the "moveable fire load sheet".

This sheet is crucial in ensuring in-depth defense of equipment items and developing a questioning attitude. It details storage areas and their capacity (nature of the products and maximum quantities authorized) which have been determined according to the detection and protection capacity of the rooms, the distance from any ignition source and the absence of safety-related equipment.

This leaflet is a simple, inexpensive method which attracts people's attention and gives them additional reminders. It is sent to each member of staff individually by post and is also available in racks located in areas where people pass through. It is also publicized on the public address terminal (PAT) television screens installed in over twenty areas on the site. It will likewise be included in the new version of the welcome package (in the same way as other information leaflets), to be given to all new employees from 1 July 2007.

The “moveable fire load sheet” is supported and promoted by a manager of the site, thus ensuring that the initiative receives customized attention.

4. MAINTENANCE

4.1. ORGANIZATION AND FUNCTIONS

The Maintenance Department is responsible for completing all maintenance activities at the plant. This includes all maintenance predictive, corrective, and preventive programmes along with an initial review of new work notifications with an initial Fix-it-Now (FIN) approach at each unit. Maintenance workers also implement installation modifications requested by Engineering Support and support refueling outage departments.

Nuclear safety and maintenance policies are clearly stated at a high level and communicated to maintenance staff. These expectations are also documented on a poster for all maintenance staff attention. Everyone is expected to carry a copy of the Memento document on plant expectations in the field. A review of two Individual Performance Agreement documents (PACTs) shows that the objectives are assessed in the performance plan reviews of individuals. The memento is applicable to both staff and contractors.

The maintenance department does have a limited set of indicators. However, the team found a concern with the lack of an all-encompassing set of metrics and performance indicators established for setting targets and monitoring performance down to a crew level and rolled up to a department level. There are no detailed indicators for each maintenance team in areas such as industrial safety, nuclear safety, budget, radiation protection, training, corrective actions and human performance events within the maintenance department. This can lead to an incapability of maintenance managers to recognize weak performance in certain areas, therefore an inability to put in place corrective or mitigating actions to correct it. Goals and objectives are communicated to maintenance managers to perform observations in the field. Indicators are established; however performance did not meet the target. The team understands work has started to enhance these metrics and indicators, and the team encourages the maintenance department to complete this project and use them to manage performance. The team also addresses a suggestion to the plant, which is developed in Management, Organization and Administration (MOA) area.

Many of the maintenance policies and programmes are recent at the time of the OSART visit. The implementation of these new policies and programmes is still in progress. Discussions with some of the individual project leaders indicate knowledge of where they want to be. However action is still required to continue the implementation of these various projects to full term. The team encourages the plant to continue developing these various policies such as the pre-job brief into a mature programme based on industry best standard. A recommendation is developed in MOA area to detail this issue.

A new maintenance organization has recently been created. Significant improvements have been made to create composite crews such as the valves, rotating equipment, and cranes & hoists crews. The centralization of the maintenance team is positive and the approach of a FIN team in each unit looking at each new notification is innovative.

The total number of people in the maintenance department at the plant is 330 staff. Even though there are currently several vacant positions in the new organization, the plant has a solid strategy and action plan in hiring new people to fill these vacancies.

The team has observed a lack of commitment and enforcement within the maintenance department for industrial safety. There were instances of blocking access to phones and in one instance to a fire extinguisher and an emergency stop push button for a rotating tool. Personnel were frequently observed not wearing safety glasses, gloves or ear plugs when required to do so by procedure. In addition to this, an action arising from the event report issued on 24 February 2004 requested a modification to install emergency showers near the battery rooms in Unit 1. There are no emergency showers installed near the battery rooms on Unit 1. Two safety ladders did not have any kind of safety chains or barriers. The team developed an issue in the MOA area on that topic.

The plant started a field observation programme for managers to observe field activities in the plant including housekeeping tours. With the exception of most senior maintenance managers, compliance with this programme is low. This is an excellent opportunity for managers to be in the field observing how conduct of maintenance is meeting management expectations, and coach or recognize staff for desired performance. The team recommends the maintenance department to increase and enforce its commitment to the field observation programme to ensure management expectations are met in the field and that expectations around safety are enforced. An issue was developed in MOA on that topic.

Good coordination exists among different maintenance groups at the plant, as observed during a weekly coordination maintenance meeting with all the maintenance managers and the maintenance director. These recent changes in the organization were evaluated as positive.

The maintenance expectation at the plant is that contractors work following the same expectations as maintenance staff on-site. It appears that contractors may not be meeting these expectations due to some weak behaviors observed in the field. A contractor was observed not wearing eye protection while performing work where this protection was required. In addition, report S4976 on accident statistics for the year 2006 shows a high percentage of first aid accidents for contractors that are trended upward. The team strongly encourages the plant to make further improvement in that area.

A plant review was performed analyzing the current qualifications of maintenance personnel against the required qualifications. There are no indicators at this moment to determine individual and crew training qualifications and job qualification index.

The plant has taken on a mission to improve its safety performance in many areas with a goal to meet industry standard practices for nuclear power plants. This was a very large undertaking and challenge for the plant in preparation for the OSART visit. The structured and efficient approach to implement new practices and improve existing ones at the plant demonstrated an engaged team with a strong focus and desire to improve its current status. This was demonstrated by appropriate behaviors and commitment from the various project leaders. The team recognizes that efforts have been done and is confident on the future improvement.

4.2. MAINTENANCE FACILITIES AND EQUIPMENT

The plant has adequate maintenance facilities. Maintenance shops are located at each unit. The unit maintenance shop is also connected to the hot shop in the Radiation Control Area (RCA) through a controlled access.

There are few mock-up facilities in place at the plant for training maintenance staff. Most of the maintenance skills training are delivered outside of the plant in external facilities operated by other utilities, suppliers or third parties. One of the new initiatives the plant has undertaken was the construction of a new human performance simulator. This is not only for plant staff, but also for contractors. The team encourages the plant to pursue this great initiative and to enhance realism based on feedback that was provided by the team.

Equipment and tools in the maintenance tool crib and the hot shop are well segregated and controlled. There are many dedicated boxes containing special equipment. One area of good performance was the identification of equipment. Slings and shackles are well maintained and consistently identified with a common method to know the year of expiry. Stock of foreign material exclusion (FME) material is readily available in all areas of the plant.

A tour of the unit 1 decontamination facilities showed a well-kept decontamination facility. This was very clean considering unit 1 had recently completed a refueling outage. Chemical storage cabinets were observed in the maintenance decontamination area and in the maintenance shop having no ground cables attached, no inventory list of chemicals stored and no material safety data sheet (MSDS) attached to the individual containers. The team encourages the plant to complete the initiative that is in progress to control and identify chemicals in the plant. Good practices developed in chemistry department regarding storage of chemical should serve as example to progress in the safe storage of hazardous chemicals maintenance facilities.

4.3. MAINTENANCE PROGRAMMES

The plant has a process in place to identify scope, frequency and criteria for preventive maintenance.

A programme is in place for predictive maintenance which includes vibration monitoring, oil analysis and thermography. It is not clear at this time what is done with this information as it may go to separate departments depending on what type of results come in. There is no overall owner reviewing all the data and trends and providing appropriate actions as required. In addition, system health reports tracking performance of these various systems and equipment only exist for some specific equipment. The plant is also looking at a new initiative with Reliability Centered Maintenance (RCM) and is aligned with AP913 and other industry good practices. The plant is prioritizing this on criticality and single point of vulnerability along with failure mechanism and rate. This is a positive indication of the plant moving forward to align itself with industry best practice.

A programme for in-service inspection (ISI) exists and is in compliance with regulatory and technical specifications. Documentation is extensive and proper reviews and signatures are obtained. Completed inspection results are reviewed to ensure the criteria and specifications specified in tests are accurate. Indicators and metrics are not in place yet to monitor and trend performance.

The ISI department has recently relocated and is physically located with the repair-replacement department. Documentation is easily retrievable at the work location of the ISI department; however, documentation is not electronically archived and available to plant staff on the intranet. The team encourages the plant to go further in that direction.

The creation of a repair-replacement database internally developed at the plant has brought about positive performance results. This was created to meet deadline requirements for essential reports from the appointed organization enforcing ASME, for increased precision and completeness of the different documents issued, for more efficient management of operating experience (OPEX) and of the work records so as to plan future work. The team recognizes this as good practice.

4.4. PROCEDURES, RECORDS AND HISTORIES

A plant policy exists on the use of procedures and clearly identifies the level of usage in the field. The maintenance department however does not have a systematic process for reviewing and updating plant maintenance procedures to include adequate information providing more step by step instructions and incorporating operating experience to maintenance staff when performing work in the field. An issue has been developed on that purpose. Furthermore, the team encourages the plant to provide a controlled copy of the approved procedures in an electronic manner via the work management tool "Systems, Applications and Products" (SAP).

Maintenance history files are located in unit 1 maintenance shop. They are stored in binders and accessible to staff. There is no electronic method to capture or archive this information for electronic access and trending. The team strongly encourages the plant to electronically archive these documents for easy review and retrieval by plant staff.

The team observed in some cases a lack of procedures or procedures having missing or inadequate information that could lead to equipment not able to meet its design function and mission time. This could also lead to premature failure of equipment and possible safety hazards to plant personnel. The team recommends that the maintenance department create a specific process for reviewing and updating plant maintenance procedures to include adequate information providing more step by step instructions and incorporating operating experience to maintenance staff when performing work in the field.

4.5. CONDUCT OF MAINTENANCE

During the past year the plant has done a good job in implementing a foreign material exclusion (FME) plan. This new programme has been benchmarked externally from other plants and is based on industry best practice. The FME programme is developed and implemented in the plant. Procedures are in place and expectations are clearly communicated through the “memento” and initial training. FME material is consistent in color and is very well laid out in the plant and accessible by all personnel. The team however has observed some non-compliance to FME expectations in the field. There were examples of FME issues in the fuel pool, maintenance shop and in the field on some activities that were in progress. The team encourages the plant to continue the effort that was started on the FME programme and to continuously reinforce management expectations in the plant.

Operators are responsible for the preparation and application of work protection. Maintenance has no accountability and there is no procedure in place for maintenance staff to ensure they have adequate isolation and protection when performing work. The electricians have a practice where they can place a green lock on a breaker used for isolation of work, however this is not documented. The team recommends the plant to improve that area and this issue is developed in Operations area.

4.6. MATERIAL CONDITIONS

Material condition in the plant is not always to industry standard or to the same condition as found in the radiation controlled area (RCA). The team observed many fluid leaks, equipment missing bolts and hangers, damaged insulation, corrosion on pipes, and the standard on material condition is below acceptable criteria. The team understands that material condition initiatives were prioritized in the RCA, however the team encourages the plant to continue material improvements in the powerhouse and other premises of the plant.

Leaking valves and equipments observed by the team could create safety hazards to plant personnel and equipment, and safety related equipment may not meet mission time due to impaired function. Leaks may also impact power generation and leaks generally contribute to an overall negative impact on housekeeping and material condition. The team recommends the plant to develop and implement a more aggressive and systematic action plan with a composite team approach, objectives, and metrics to identify, contain, report, repair, monitor, trend and control leaking equipment and components in the plant.

4.7. WORK CONTROL

A formal centralized or unitized work control department does not exist at the plant. Work planning is not process oriented as compared to industry standard. A procedure exists describing how work is reviewed and prioritized. Work is planned on a daily basis each morning. Appropriate representatives from individual departments attend the meeting to review unavailability of equipment, new notifications coming in, and establish clear direction for the day. New work is assigned a priority and a requested schedule date is established. There is a weekly meeting which reviews the work for the following week. One element missing from the work control process is a formalized 13-week or similar type process where work can be systematically aligned to functional equipment groups to a defined workweek. This would align the preventive and corrective programmes and allow a more efficient process to ensure that systems can be properly aligned and that work is properly planned and ready to be executed.

Indicators are provided at a tier 1, tier 2, and tier 3 level, however they are not systematically organized and developed to provide information with the health of some work control processes. For example, there is no indicator to track the flow of work from incoming new notifications through to adherence of schedule dates and completion of work. There is no opportunity for the plant to determine if there is a problem and to create an action plan to correct any negative trend.

A large backlog of plant work exists. The total backlog of preventive and corrective work was obtained by a manual search of the work planning tool "Systems, Applications and Products" (SAP). There is a total backlog of about 1000 Work Orders in Unit 1.

The tier 2 key performance indicators (KPIs) from the end of March 2007 showed the preventive indicator as red for the past 12 months. The ratio of preventive maintenance work against corrective is well above the industry standard. In addition to this, the large amount of preventive and corrective that are late in completion to their scheduled date indicates a lack of a mature work control process that monitors schedule adherence and plans forward in a logical manner. It is also difficult to ascertain how work is aligned to system configuration beyond the next week due to the nature of only having a one-week look ahead.

The team strongly encourages the plant to review the existing work management process and benchmark top performing nuclear power plants in order to improve the existing process and reduce the large backlog is a systematic way.

4.8. SPARE PARTS AND MATERIALS

The plant has a good process and infrastructure for spare parts and materials. This is effectively organized as two separate independent paths are followed until the material is receipted. Storage facilities are well organized and housekeeping is clean. Stock levels are monitored and defined by maintenance staff. There are warehouses at each unit and at the Doel nuclear power plant. There are processes to ensure materials come in staged the day prior to work execution. A summary report on an internal audit performed last year (AQ-06/009) was reviewed by the team. Many of the actions in this report are complete and many of the outstanding actions were transferred to the OSART preparation plans.

4.9. OUTAGE MANAGEMENT

An outage organization and outage management procedures exist at the plant. The organization is multi-discipline and although each outage at an individual unit is treated as a single project. Much of the outage team essentially stays together. This is positive as experience is maintained and allows for continuous improvement in outage preparation and execution.

There are little and in some cases no standard industry outage indicators and metrics to monitor pre-outage preparation and outage execution. The information is available in spreadsheet format and the outage manager is aware of status. However, there is no work down curve and trend to monitor performance. There is no opportunity to review trends and proactively create corrective action recovery plans in order to meet milestones or work down targets. The team strongly encourages the plant to perform benchmarking in this area and develop an outage indicator and outage metrics package for plant management to review performance of outage preparation and outage execution.

A review of the progress of the milestones associated with the upcoming unit 3 refueling outage was performed. Out of 18 preparation milestones, only one milestone is on track. The team encourages senior plant management to be engaged in the review of outage preparation, and to reinforce accountability to individuals for meeting commitments.

The probabilistic safety analysis (PSA) tool is not used to provide safety in depth during an outage. Even if it was available for use, there is no scheduling software to provide interface between the schedule and the PSA tool. The lack of a project scheduling software tool also limits good information flow and control such as the amount of float and variance for each activity. The team encourages the plant to benchmark the use of project scheduling

4.3. MAINTENANCE PROGRAMMES

4.3(a) Good practice: Document management database developed internally at the plant by the repair – replacement section.

A document management database was created to meet deadline requirements for essential reports from the appointed organization enforcing ASME, for increased precision and completeness of the different documents issued, for more efficient management of operating experience (OPEX) and of the work records so as to plan future work.

Other areas for improvement in this database were:

- To incorporate all information that is available at different times, for the purpose of work planning.
- To allow technical specialists more time to go into the field.
- To help new employees gain a faster understanding of the workings of ASME and of repair-replacement management.
- To meet the QA requirements for repair organization.

This database was developed by the repair – replacement section which was recently reorganized as part of the main organizational change programme initiated in 2006. It includes ASME requirements as well as other relevant business codes and mandatory requirements. In addition to this, it also includes all preventive aspects associated with work package preparation such as foreign material exclusion (FME) programme, risk assessment, industrial safety, environment, radiation protection, and hot work in a cohesive manner from beginning to end.

With respect to increase in performance, the repair team looked at results from previous outages. In comparing results, performance was increased in the following areas;

- Improved output times for evaluation reports. Today, nearly 100% of reports are drafted in a very short term.
- Improved output times for Nuclear In Service (NIS) 1 & 2 reports so that nearly 90% of these documents are issued within 90 days of start-up (ASME requirement).
- Improved the efficacy of document management and the scheduling for outage repair and replacement programmes.

The repair team has been able to offer additional assistance in terms of expertise with the same number of staff at hand. The department has strengthened the repair technical presence in the field rather than invest time in management of technical documents. The department has made overall document management database much more solid and accessible to everyone.

4.4. PROCEDURES, RECORDS AND HISTORIES

4.4(1) Issue: The maintenance department does not have a specific process for reviewing and updating plant maintenance procedures to include adequate information providing more step by step instructions and incorporating operating experience to maintenance staff when performing work in the field.

Even though many procedures contained adequate information and instructions such as procedure 214308/SM/02 on the Pressurizer Relief Valve and 22.73.34/SM01 on the overhaul of PCT3-CUS-P02, observations in the field showed that some maintenance procedures were very general in nature relying on the skill of the trade or manufacturers manuals, and in some instances did not contain valuable technical information based on supplier manuals, industrial safety and Operating Experience. In some cases, there were no procedures to perform work:

- Procedure for disassembling the charge pump CCV3 was very general in nature. It relied on the skill of the trade as opposed to having discrete instructions. There was no information on the torque sequence and torque values when reassembling the pump cover. Much of the information relied upon original manufacturers manuals.
- Disassembly of the impeller rotor on the charge pump did not have a plant procedure. This relied completely upon skill of the trade and on the manufacturer's manual, which was not at the job site due to radiological environment.
- A procedure did not exist for the replacement of radiation detectors on the laundry monitors. The technician was performing this task for the first time, however, he was with an experienced worker.
- A work was executed on April 27 2007 to perform a monthly battery bank preventive maintenance inspection. The procedure 551307/EF/001 issued on May 2006 did not contain valuable instructions relating in industrial safety and in-house operating experience was not captured in procedure. An event occurred on February 18 2004 when a hygrometer exploded due to static shock. Some corrective actions were taken on REVE/ 1/04/11 however there was no action to correct the procedure.
- A maintenance procedure 642314/E1/319 on Pressurizer level transmitter LN 23 had a requirement to be in hand and followed step-by-step. The procedure in section 3 "Work to be performed" did not have any steps listed. It relied on "skill of the trade" to perform the work. A general calibration procedure was attached as an appendix for information.
- There was no approved procedure to perform work on PCT1-CVD-2V111Vv1/2/3. A technical note was produced for this which was handwritten and had proper approvals and signatures.

The lack of procedures or, in some cases, procedures having missing or inadequate information may lead to equipment not able to meet its design function and mission time. This could also lead to premature failure of equipment and possible safety hazards to plant personnel.

Recommendation: The maintenance department should create a specific process for reviewing and updating plant maintenance procedures to include adequate information providing more step by step instructions and incorporating operating experience to maintenance staff when performing work in the field.

IAEA Basis: NS-G-2.6; 4.23: Procedures and work related documents should specify preconditions and provide clear instructions for the work to be done, and should be used to ensure that work is performed in accordance with the strategy, policies and programmes of the plant. The procedures and work related documents should be technically accurate, properly validated, verified and authorized, and they should be periodically reviewed. Human factors and the ALARA principle (to keep radiation doses as low as reasonably achievable) should be considered in the preparation of work instructions.
NS-G-2.11; II.13: Lessons learned. The report should clearly identify learning points. The communication of lessons learned can lead to enhanced safety, positive changes in working practices, increased reliability of equipment and improvements in procedures. The sharing of lessons learned from operational experience is one of the most valuable parts of the process of feedback of operational experience.

4.6. MATERIAL CONDITIONS

4.6(1) Issue: The plant did not develop and implement a comprehensive enough and systematic action plan with a composite team approach, objectives, criteria and metrics to identify, contain, report, repair, monitor, trend, and control leaking equipment and components in the plant.

Leaks were observed by the team in Tihange 1 in spite of the unit having just come out of a refueling outage. These leaks included steam, oil, water and boron:

- A document exists to describe the process used to identify and repair leaks; however, there is a provision where some leaks are acceptable to remain as is.
- There are two leaks from the main steam line safety valve on the west building roof.
- There are steam leaks from both high-pressure turbines.
- Oil was observed at two places under the bearings of both turbines.
- There is an oil leak on the bearing of P1PV1.
- Pump P01BD1 recirculation for spent fuel pool is leaking at the packing of the pump shaft and crystallized boric acid is accumulated in the leakage collecting vessel.
- There were 20 leaks were recorded at the daily coordination meeting held on Wednesday, May 9. This is unusual considering the unit is just coming out of an outage.
- There were 5 leaks that were added to the daily coordination meeting held on Thursday, May 10.
- There was oil located at 2PO2HR1 along with oil soaked absorbent material.
- EAN-1PO1VhA in the pumping station has a water leak.
- Oil leak at P1EB3; 1V 3EC4 and 1V 3EC2 in the turbine hall; 1V2 00 ECI and 1V 201 EC1 in the turbine hall basement.
- A water leak was observed at PCT1-EAN-2V308 VhB. There was no notification in the System Application Products (SAP).
- Currently, there are 70 identified leaks at Tihange 1 with 5 leaks coded to be repaired at the next scheduled refueling outage.

Leaking valves and equipments could create safety hazards to plant personnel and equipment, and safety related equipment may not meet mission time due to impaired function. Leaks may also impact power generation and leaks generally contribute to an overall negative impact on housekeeping and material conditions.

Recommendation: The plant should develop and implement a more comprehensive and systematic action plan with a composite team approach, objectives, and metrics to identify, contain, report, repair, monitor, trend, and control leaking equipment and components in the plant.

IAEA Basis: DS437 Draft 3: 4.34: Personnel assigned the task of rounds should be responsible for verifying that operating and standby equipment operates within normal parameters. Operators should take note of degrading equipment and environmental conditions such as water and oil leaks, burned-out light bulbs and changes in building temperature or air cleanliness. The equipment problems noted should be promptly communicated to the control room personnel and corrective actions should be initiated.

6.20: The plant housekeeping programme should provide for maintaining a high standard of operational conditions in all working areas. They should be continuously preserved, well lit, clean of lubricants, chemicals or other leakage, free from debris, prevent intrusion of foreign objects and should create an environment where all deviations from normal conditions are easily identifiable (such as small new leaks, corrosion spots, loose parts, unauthorized temporary modifications and damaged insulation). Challenges due to the intrusion of foreign objects or long term effects from environmental conditions (i.e. temperature or corrosion effects or other degradations in the plant that may affect the long term reliability of plant equipment or structures) should be evaluated as part of this programme.

INSAG-13; 92: Specific studies and general experience have shown that frequently occurring underlying conditions at those plants which have had significant problems include:

– Acceptance of low standards of plant condition/housekeeping.
– Failure to recognize that performance is declining and to restore higher levels of performance in specific areas at an early enough stage.
– A lack of accountability among line management and workers.
– Ineffective management monitoring and trending of performance.
– Inadequate and/or poorly used procedures.
– Insufficient use of operational experience feedback and root cause analysis programmes in the analysis of events and ‘near misses’.
– Failure to benchmark against those with better safety performance.
– A lack of awareness among the top managers about the principal deficiencies and associated corrective actions often reinforced by a ‘good news’ culture.
– Inadequate or insufficient self-assessments being carried out on issues relating to safety culture.
– Inadequate capability for supervising and monitoring contractors.

5. TECHNICAL SUPPORT

5.1. ORGANIZATION AND FUNCTIONS

The technical support functions are distributed among several departments of the plant – Operations, Engineering, Maintenance and Care. For any complex modernization projects, the use of certified contractors for design preparation, safety analysis and independent review is also available. The Engineering department has a leading role in the fulfillment of technical support functions. This includes the preparation and implementation of plant modifications as well as maintaining all computer applications activities. The core management, including reactor engineering, core monitoring and fuel handling is performed by the Fuel corporate department, while the Operations, Maintenance and Care departments manage the surveillance programme.

A new Engineering Department structure was established a year ago before the OSART visit. A master document "Engineering Support Department Organization"–REF/00/027 establishes the responsibilities of the Engineering department with the aim of meeting the plant management's expectations. At the current time, the organizational structure is clearly defined and understood. However, plant organization change is still in the process of implementation. The final structure of the Engineering department is going to be completed in 2012.

There are 24 employees in the Engineering department**,** of whom 12 are engineers. In accordance with the plant management staffing plan of 2010, the Engineering department will consist of 48 employees, of whom 26 will be engineers. The insufficient amount of specialists originated difficulties to carry out activities for conducting the modification process. The modification process is shared between the Engineering and Maintenance Departments at the plant. Because of this shortage of personnel, the Engineering department cannot control the full modification process. The other activity which currently is not always conducted by the Engineering Support department is the surveillance test programme for safety related equipment. This is managed by the Operations department.

There is an established minimum amount of years' experience for each position in the department, thus providing the successful execution of the assigned task. Therefore, some of the positions (Probabilistic Safety Analysis engineer, Civil structures engineer etc) have not yet been filled.

Currently two engineers have got operational license level "B", while a few months ago two other engineers had got license "B" too. However, when they started to work for the engineering department it was not necessary for them to keep their license.

There is no Probabilistic Safety Analysis (PSA) engineer in the Engineering Department. The plant relies fully on the 10 (ten) Tractebel PSA engineers, who are not present on site. To resolve this shortage, the Engineering department started training a new engineer, who will be assigned to the PSA engineer position once he has completed his training programme. There is no civil structure engineer in the Engineering Department. There is only one civil structure engineer at the plant, but this engineer belongs to the Maintenance department. Nevertheless, when necessary, the civil engineer deals with the activities related to the Engineering department in relation to civil structures.

The plant has a performance management system. The plant and department's objectives are disseminated in the form of individual performance objectives for each engineer. The individual develops these objectives at the beginning of the year in accordance with their line manager. A mid-year interview is scheduled to monitor the objectives. The appraisal is conducted at the end of the year. The result of the assessment triggers a system of financial rewards with fixed and variable bonus components. A system of annual self-assessments was introduced in early 2007, shortly before the OSART visit, to evaluate the consistency between individual skills and job profile. This system allows each engineer to evaluate his or her skills in light of the skills required for the post. The engineer then draws up a training plan, in consultation with their line manager, which will enable them to acquire and/or strengthen the skills necessary for the performance of their role.

The commitment to safety is a priority for every engineers and specialists in the Engineering department. The commitment to safety, as well as adequate comprehensive arrangements has been established to promote safety concerns and feedback from individuals. Safety meetings and feedback to the managers manage this safety commitment. The master document of the Engineering department developed appropriate arrangements to monitor the effectiveness of communication and to act promptly to eliminate any up coming deficiencies.

The department implements effective planning of its activities as well as a scheduling system to carry out all assigned responsibilities when required.

Interfaces with other plant departments and off-site supporting organizations are clearly defined and well understood by means of adequate documents. All interfaces and communications are executed in a proper manner and at the appropriate time and results are visible.

During the outage periods, the tasks and responsibilities of the engineering department groups are clearly established and understood. Special attention to safety is given during this period.

The department's objectives are well demonstrated and are incorporated into an individual training plan for each engineer and specialist.

Nowadays the department's organization ensures that all personnel who may be required to perform activities that affect safety have a sufficient understanding of the plant and its safety features. The managers have supervisory skills and safety management principles that are of relevance to their work. They are trained to promote safety culture and conservative decision-making by means of positive feedback and understanding of how to perform safely their duties. Other department personnel involved in the engineering process demonstrate the appropriate knowledge, skills and attitudes to ensure safety under a variety of conditions relating to their duties.

Plant management understands and pays enough attention to the role and responsibilities of the Engineering department. All plant management considerations and decisions are transferred to the department on time and a feedback process takes place.

The effective communication between the engineering department managers and plant staff is executed in an adequate manner as established in the plant procedures.

5.2. SURVEILLANCE PROGRAMME

The plant established Surveillance Programmes (SPs) to carry out all necessary activities implemented by the surveillance tests and the In-Service Inspection (ISI). The aim is to confirm that the relevant safety related systems structures and components (SSC) are available and their readiness for performing their functions is in accordance with the design basis and the technical specifications (TS) of the plant.

The responsibility for conducting the SP is shared by all Operational departments.

The SPs are devoted to the two safety important parts of the SSC package:

- ISI of the Reactor Pressure Vessel (RPV), Reactor Vessel Head (RVH), Pressuriser, Steam Generators (SG) and associated piping, Primary circuit piping, other equipment of the primary circuit as well as Secondary circuit piping.
- Safety systems pumps, valves, logics, interlocks, protections, Diesel Generators (DG).

The scope of the SPs is determined by the Technical Specifications of the plant. There is a general management document which describes the SP and details all the relevant roles and responsibilities.

The ISI of the RPV, RVH, Pressuriser, SGs and Primary circuit piping, other equipment of the primary circuit as well as secondary circuit piping is performed in accordance with national and international standards, by observing all manufacturers requirements and criteria. The associated ISI computer application tools and devices are licensed, verified and validated. The staff conducting these ISI activities is qualified to perform associated ISI activities. Some of the ISI are conducted by plant contractors. The applicability of the ASME code to ensure safe and reliable operation of that equipment is confirmed by results received. The results obtained from ISI are transmitted to the Authorized Inspection Organization for analyses and controls.

The surveillance programmes for the second SSC package are conducted by the Operational departments. The surveillance programme for that equipment covers all safety related equipment and the schedule for the tests ahead is issued by the System Applications and Products (SAP). To support these activities the plant issued several procedures. However, the team found some gaps related to the management of the surveillance programme. The analyses of results, comparison of criteria and acceptance of validity of the tests are not always performed in a adequate manner during the execution of the surveillance test programme for safety equipment. The team developed a recommendation in this area.

At the end of each year, the Operations department issues the report for the performed tests, any anomalies observed and actions taken. The report is distributed to the Care and Engineering departments.

The plant established and put in place documents which are related to the consistency and clearness of the surveillance tests procedures. However, the team still found that the plant does not pay always enough attention to the surveillance programme. Periodic assessment and feedback process implementation for the use of test procedures is not fully implemented. The team developed a suggestion in this area.

The plant carries out special tests to ensure all criteria related to compliance with the design basis of the new or modified system, the in-service inspection of the important to the safety equipment and safety analyses of the new reactor core low leakage pattern load scheme have been met. Also, that these satisfy the TS as well as national and international standards requirements.

5.3. PLANT MODIFICATION SYSTEM

There is a system which allows performing different modifications from the safety point of view. The modifications which are subject to the operational license are conducted by special regulatory approval and they are not subject to the plant modification system. The other modifications are divided into two groups:

- Temporary modifications,
- Permanent modifications, executed by particular departments, such as Maintenance, Engineering etc, in relation to modifications.

From the safety point of view, the modifications which are not subject to the Operational license are divided into the following groups,

- Non-important modifications (MNI): modifications which provide an impact on nuclear safety,
- Non non-important modifications (NMNI): modifications which have no significant impact to nuclear safety and/or related to safety, environmental and plant reliability,
- Light modifications (DML): all other modifications.

During the review, the team found that the plant modification system is very well known by the plant staff. Every employee can start the modification process for any equipment, system and structure by the means of a special notification modification sheet.

The process of execution of all phases of the modification to be implemented is well coordinated and the role of each department is clearly defined and performed in a adequate manner. During the review, the team recognized the important role of the engineering department modifications section personnel in the scope of the permanent modification process. The plant establishes clear requirements for the installation and inspection of the permanent modernizations. The process of the permanent modifications is clear, well understood and explained in the reference document for modifications. All concerned departments perform technical reviews and safety assessments of the proposed modification. The system used to carry out safety significance of the approved modifications to be executed is adequate. It categorizes precisely the modification in accordance with the national law for nuclear installations.

All modifications to be executed go through the whole modification process conducted by the Modifications Committee (CMOD). The final decision to implement the modification is done by the Plant Operations Review Committee (PORC) for MNI. When the modification is safety related, and in accordance with its significance, the corresponding approval is received from authorized institutions. A good example of the plant's modification system process is the modification of the containment basement sumps to protect them from debris and insulation pieces clogging them up in the event of a loss of coolant accident (LOCA).

About 16 permanent modifications were executed during the annual outage of the unit 1. However, the team notices some omissions in the modification process where the former equipment has not been removed. Sometimes not enough attention was paid to fully handover the modification. This relates to both temporary and permanent modifications. The team strongly encourages the plant to enhance all aspects of the modification process.

Every ten years the plant performs a periodic safety review of each unit. The management of the safety analysis report (SAR) and its chapters are conducted by the appropriate document, which covers all aspects of the SAR activities to be accomplished. The operational approval for unit 1 requests that a review of the SAR must be conducted every two years. However, the plant performs the process of SAR updating on a continuous basis. The team encourages the plant to continue the ongoing process of SAR updating.

5.4. REACTOR CORE MANAGEMENT

The reactor core management process is conducted by the Fuel section. The Fuel section is part of the Fuel corporate department. The personnel have got adequate qualification and are very experienced. Programmes are established to manage the core and its behaviour. The content of the programmes is adequately tailored. The core management activities are performed by both the Plant Fuel section and by the Tractebel, who starts from the beginning of the plant operation. The operational systems used for new core loading scheme determination and the core safety analysis are licensed, verified and validated.

The plant conducts the core management programmes by means of procedures, to ensure that all tests are in compliance with the Technical Specification requirements. However, during the review, the team found that the plant does not revise and update the procedure for conducting neutron-physics tests in the hot shutdown condition prior to unit start-up in order to provide clear and precise requirements for performing start up activities with the new core. The team developed a suggestion for this area.

The visual inspection and the sipping test of 100% of the reactor fuel assemblies is performed in compliance with international, national and manufacturer’s requirements. The plant also has appropriate procedures to conduct activities on the damaged fuel.

Each month the Fuel section issues a report consisting of the main neutron – flux characteristic changes during the expired month as well as the characteristics of the expected behaviour of the core. The report is sent to the regulator and to Operations department.

The plant kept all the history and records of the fuel movement inside and outside the reactor pit, as well as the information relating to the spent fuel pool content.

Nowadays, fuel integrity is maintained in a safe manner. Appropriate operating procedures sustain fuel integrity. The spiral joints, which in the previous fuel cycles originated damage the fuel assemblies had been removed from all primary circuit locations and replaced by safe ones. The detailed analyses of the failed fuel were conducted. The damaged fuel had been removed from the core to the spent fuel pool and the fuel assemblies had been repaired.

5.5. HANDLING OF FUEL AND CORE COMPONENTS

The plant developed several documents to handle the fuel and the core components. The national, international and the owner group safety requirements are strictly applied by each activity’s associated procedure. It is performed at all locations where the fuel and the core components are handled.

The plant recently has put in place a policy for foreign material exclusion (FME) in all locations of the plant. The policy is executed by means of procedures, rules, materials and personnel attitude to the subject. During the review the team recognized that the FME policy is well promoted by the management and understood by every employee of the plant. Adequate precautions and measures are placed at the appropriate time. However, the team still found some omissions of the FME policy implementation in the vicinity of the spent fuel pool (SFP). The team encourages the plant management to look in details for the strict application of the FME policy in the vicinity of the SFP.

The team recognized during the review that the plant developed and put in place adequate procedures relating to the activities with irradiated and new fuel assemblies in the vicinity of the SFP. However, some omissions were found relating to the prevention of heavy objects movement at the spent fuel pool location. These are related to the floor rating information and to the permitted movement of the crane. The team encourages the plant to enhance the policy of heavy objects movement at the SFP locations.

The new fuel check is performed by the manufacturer and independently by Tractebel. When the new fuel is accepted at the spent fuel pool location the plant performs a complete visual inspection of the fuel assemblies as well. The storage places are approved for the prevention of fire and/or flooding. An independent review of the fuel is performed by Euratom and IAEA periodically every three months.

5.6. COMPUTER BASED SYSTEMS IMPORTANT TO SAFETY

The plant has got a process which governs all aspects of the utilization of computer applications. Computer applications are used as process applications and as administration applications.

Computer based applications are classified into five categories, taking into account their importance for plant safety. Categories I, II, and III contain safety-related applications, while category IV contains applications with indirect impact to safety, and category V has applications with no impact on safety. A quality assurance programme is in place at all stages of the computer applications process for their usage. The process management of the computer applications is performed by the engineering department. Several services of the maintenance department of the plant provide technical support and conduct the maintenance for most plant process applications. The responsibilities and organizations for management, maintenance, technical support and implementation of the computer based system modifications are clearly defined.

For categories I, II and III applications enforce the same rules as for the safety system to which there are related. Therefore, the periodic surveillance programme is placed to check their availability.

The computer applications documentation is kept in the engineering department and in the maintenance department.

A single database called THEMIS has been created in the Engineering department in order to centralize all the data from the surveillance programmes. It contains all the legal requirements (Safety report, ASME codes, etc), insurance requirements, and maintenance requirements including manufacturers' prescriptions, requirements linked to various certificates (ISO, etc) and operating experience. The team developed a good practice in that area.

DETAILED TECHNICAL SUPPORT FINDINGS

5.2 SURVEILLANCE PROGRAMME

5.2.(1) Issue: The analyses of results, comparison with criteria and acceptance of validity of the tests are not always performed accurately during the execution of the surveillance test programme for safety equipment.

During the review the team recognized that the plant established a solid surveillance programme for the safety-related equipment, based on the design basis requirements, national and international requirements. The surveillance programme schedule for the tests ahead is issued by the System Applications and Products (SAP). To support those activities the plant developed several procedures. However, the team found some gaps related to the management of the surveillance programme:

- A procedure governs the management of the master file of the periodic tasks. This procedure is connected with the surveillance and the post maintenance test procedures. However, clearly defined criteria are absent, in the surveillance tests.
- In the document COND/00/002 "Execution of the periodic tests" in chapter 2.5, it is written that: "staff performing the periodic tests shall note all deviations or modifications observed during the execution of the test, as well as all information enabling to understand these deviations". The team witnessed that requirements are not always implemented in practice.
- There is no established clear and precise requirement on how to confirm the execution of the surveillance procedures. For example, the Procedure EP-406-202 "Check the position of the valves for Diesel Generator No2 (GDS-2)" was signed by the operator, while the Procedure EP-406-201 "Check the position of the valves for Diesel Generator No1 (GDS-1)" was just "ticked" by operator.
- The procedure EP-406-230 "Test of safety guard systems for Diesel Generators No1 and No1 (GDS-1, 2)" was executed, but there was a remark made in black ink that the keys No 8 and 9 are at new panel TRL. An interviewed engineer, who conducts tests activities from operational support, was not able to give clear explanation of the abbreviation of that panel.
- The procedure for test of the pump EP-203-302 P3Vh train A was recently executed before the team interview. The obtained results show: ΔP= 29Bar (27±1 is requested); Speed = 3700rev/min (3500rev/min±150) – Values are out of range. No remark was added in the document. The test was accepted and validated.
- Opening of annulus ventilation check valve: calibration of the check valve, the procedure does not state which manometer should be used for the check. There are three manometers for different cases. None of them is labeled. No criteria for the test in the procedure. Hand written label are present on for the valves.
- In the procedure EP-406-300 – Start up of the Diesel generator No1 (GDS-1) with air system No1, the oil temperature reached 46°C, while the criteria is (50-60°C). There was no trending of the important diesel generator parameters even if the GDS-1 was at 1100kW el. power.

Without executing accurately the comprehensive management surveillance test programme for safety equipment, the plant would not be able to detect early deviations, abnormal behaviour and/or failure of the safety-related equipment. Thus the plant could not confirm compliance with operational limits and conditions of the equipment.

Recommendation: The plant should ensure that the analyses of results, comparison with criteria and acceptance of validity of the tests are always performed accurately during the execution of the surveillance test programme for safety equipment.

IAEA Basis: NS-G-2.11; 2.11: The objectives of the surveillance programme are: to maintain and improve equipment availability, to confirm compliance with operational limits and conditions, and to detect and correct any abnormal condition before it can give rise to significant consequences for safety. The abnormal conditions which are of relevance to the surveillance programme include not only deficiencies in SSCs and software performance, procedural errors and human errors, but also trends within the accepted limits, an analysis of which may indicate that the plant is deviating from the design intent.

5.2(2) Issue: Periodic assessment and feedback process implementation for the use of test procedures is not fully implemented.

During the review, the team recognized that the plant has a tailored and sufficient surveillance programme, which covers all aspects related to the safety-related equipment availability, on compliance with national and international standards requirements. The surveillance programme establishes the execution of the procedure for each piece of equipment. However, the team found out some gaps related to the periodical assessment of the procedures in usage and miss of implementation of the feedback process after their execution:

- In procedure INF/GDOC/017, which governs the revision and modifications of the procedures (including those connected with surveillance test programme execution), it is written that a surveillance test procedure can be modified only when the test engineer finds some violation of the results obtained, compared with expected ones. There is no periodic review based on time or operational experience.
- In the procedure EP-203-302 for P3 Vh train A, conducted on a surveillance programme test from the main control room, for one of the Auxiliary Feed Water Pumps, the team found some inconsistencies in the initial condition for running the test. At the beginning of the procedure, the necessary condition chapter it is written that the unit shall be at power or in hot shutdown condition. At the end of procedure in the chapter "Expected Criteria", it is written that the parameters of the pump correspond to 100% of the thermal power.
- In the procedure EP-203-302 on the test of Auxiliary Feed Water Pump P3 Vh train A, the team found missing requirements on the emergency shutdown of the pump and how to proceed further.
- Some batteries (at least 21) have got much more electrolytes than the "maximum" level indicated on the equipment. A surveillance test had just finished; however, this observation had not been noticed and remarked in the surveillance test procedure. A level check is not included in the surveillance test procedure.
- Nowadays, an independent review and approval of the test results are not systematically in place. The safety department and the engineering support department are not included in the process of verification.
- The content of surveillance procedures does not systematically cover the issues related to operational experience feedback.

Without executing the periodic evaluation of the content of surveillance test procedures, the independent review of the test results and the adequate operating experience feedback from previous performed tests, the plant could miss the opportunity to detect in due time the deviation from the design.

Suggestion: The plant should consider enhancing the conducting of periodic assessments and inclusion of operating experience feed back in surveillance test procedures.

IAEA Basis: NS-G-2.6: 2.11: The objectives of the surveillance programme are: to maintain and improve equipment availability, to confirm compliance with operational limits and conditions, and to detect and correct any abnormal condition before it can give rise to significant consequences for safety. The abnormal conditions which are of relevance to the surveillance programme include not only deficiencies in SSCs and software performance, procedural errors and human errors, but also trends within the accepted limits, an analysis of which may indicate that the plant is deviating from the design intent.

6.11: Data on experience with MS&I activities should be collected and analyzed in order to enhance the safety of the plant and the reliability of SSCs throughout their service life. Histories of past MS&I should be used for supporting relevant activities, upgrading programmes, and optimizing the performance and improving the reliability of equipment. Adequate historical records should be kept for systems important to the safety and reliability of the plant. Appropriate arrangements should be made for the orderly collection and analysis of records and for the production of reports on MS&I activities. Historical records should be easily retrievable for purposes of reference or analysis. The use of computerized systems for the keeping of historical records would facilitate this process.

5.4 REACTOR CORE MANAGEMENT (REACTOR ENGINEERING)

5.4(1) Issue: The plant does not revise and update the procedure for conducting neutron-physics tests in the hot shutdown condition prior to unit start up in order to provide clear and precise requirements for performing start up activities with the new core.

During the review, the team recognized that the plant has established a programme which covers the new core safety justification. The programme for execution of core loading and start up activities is developed by means of appropriate procedures. However, the team found some gaps in the procedure EP-511-732 "Procedure for conducting neutron physics tests in the hot shutdown condition" used in Unit 1:

- Measurement of the Doppler Effect was not in the scope of the start up activities agreed by the regulator. Nevertheless, in chapter 4, "Precautions", a text to measure it exists. The engineer who executed the procedure erased the associated text by crossing it out with black ink, although erasing of the text made the procedure more conservative. Nevertheless, this is not the expectation for the modification of the procedure.
- In chapter 5, "Verification of initial conditions", the text "rod drop time test has been performed" is erased. It was explained that the test was conducted before; the text had been erased in order not to conduct the same test twice. The procedure does not show when the previous test was conducted.
- In chapter 6, there is no information about the time at which the samples were taken from the pressurizer and the loops to determine boron concentrations at those locations. The engineer explained that a copy of the chemistry log with data is attached to the procedure after it has been performed, which was why no time and boron data have been entered into the procedure. The procedure contains no indication that the copy of the chemistry log with the time and data obtained should be attached to it after it has been executed.
- Many erased texts were found in chapter 6.2 on pages 9 to 15. The engineer explained that one of two proposed methods for reaching first criticality was selected; this was why the text has been erased. The procedure does not contain any requirements on how to choose one method or the other, and what should be the precautions.
- After its execution, the procedure was subjected to a quality assurance review by the same engineer who performed the test. There were no written remarks about whether the procedure was clearly understood and technically accurate. There is no independent review of the result obtained with the procedure by the Safety and Engineering Support departments.
- In chapter 6.3.2., the results of calibration of the reactivity meter are not copied into the formula for calculating the boron concentration with all rods withdrawn. This is due to the use of a computer for the calculation of this boron concentration. It was explained that the regulator still insists on keeping manual calculation of the critical boron concentration in the procedure. However, there is no information that the computer application tool replaces manual calculation.
- The procedure does not contain a chapter describing actions in the event of any safety limit being exceeded.

Without using a procedure that is updated in due time for conducting the neutron-physics tests in the hot shutdown condition, the plant could face unexpected conditions of the reactor core during start-up.

Suggestion: The plant should consider revising and updating the procedure for conducting neutron-physics tests in the hot shutdown condition prior to unit start up in order to provide clear and precise requirements for performing start up activities with the new core.

IAEA Basis: NS-G-2.5: 2.12: To ensure safe operation of the core, an effective core operation programme should be established. Optimization of fuel utilization and flexibility in core operation should not compromise safety. The core operation programme should include, but should not be limited to, the procedures and engineering practices which:

- Ensure that all pre-start-up procedural requirements are met and functional tests are completed and that all required documents and/or procedures are updated prior to reactor start-up.
- Ensure that required measurements of criticality and shutdown margin, low power physics tests, core physics measurements and power raising tests are performed during reactor start-up.
- Establish and implement a surveillance programme for all required in-core fuel management and reactivity management functions.

2.14: The operating procedures for reactor start-up, power operation, shutdown and refueling should include precautions and limitations necessary for the maintenance of fuel integrity and compliance with the operational limits and conditions throughout the life of the fuel.

NS-G-2.2; 4.1: … exceeding a single safety limit does not always lead to the unacceptable consequences mentioned earlier. Nevertheless if any safety limit is exceeded, the reactor should be shut down and normal power operation restored only after appropriate evaluation has been performed and approval for restarting has been given in accordance with established plant procedures.

5.6 COMPUTER BASED SYSTEMS IMPORTANT TO SAFETY

5.6(a) Good practice: A single database called THEMIS has been created in order to centralize all information to support the surveillance programme. It contains all the legal requirements (Safety report, ASME, etc), insurance requirements, maintenance requirements including manufacturers' prescriptions, requirements linked to various certificates (ISO, etc) and operating experience. Searches in the database structure can be performed by type of equipment and by type of requirement. All requirements applicable to the equipment concerned can be consulted online. Moreover, a link to Systems Applications and Products (SAP) gives access to the list of periodic tasks performed on specific equipment.

This database is a support tool, which helps to analyzing the requirements related to specific equipment and allows easy access to the highest-level requirement. Software development (material & people) is inexpensive compared to the benefits.

The main benefits are significant time savings for engineers when performing equipment analyses thanks to quick and easy access to relevant data and cost savings due to reduced need to outsource analyses. The database also supports in safety decision-making through automatic access to the most restrictive requirement.

6. OPERATING EXPERIENCE

6.1. MANAGEMENT

Expectations of the top management on Operating Experience (OE) are defined in the reference document on nuclear safety issued by Electrabel Corporate. In turn, these objectives are conveyed to the plant staff by the "Global Objectives of Tihange, 2007" document issued by the plant Director. At the plant, the process and performance management (PPM) department, established in early 2006, is assigned to be the driving force for the OE programme. This department is a corporate entity with a technical and human performance section. The PPM site manager is also a member of the plant management team. The internal OE is delegated to the Exploitation Coordinator Manager (ECM) who reports to the plant operations manager and the responsibility is further delegated to the Single Point of Contact (SPOC) at the department levels of the plant. External OE is the responsibility of Operating Experience Feedback of so called retour d'experience (REX) manager in the PPM department. Thus the responsibility of OE is spread out among various departments and sections.

A number of new organizational and process changes in OE such as a dedicated group for human performance have been recently initiated at the plant. These changes have started giving results in terms of an increase in the number of events reported and a reduction in the number of corrective action (CA) backlogs. However, during the transition period, the roles and responsibilities of individuals, departments and sections were not clearly defined and assigned which resulted in gaps in performance. For example, during the year 2006 around 800 event reports so called "experience forms" (FEs) were raised. About 40% involved human performance issues but detailed analysis was carried out for only one human performance event. The team also observed that some processes in the operating experience area like criteria for event screening by the ECM and the SPOC and criteria for reporting of low-level events have not been adequately documented. This could lead to performance problems.

The ECM and SPOC are the key persons in the OE process in the plant. However, OE is one of their many responsibilities and they work on OE only part time. In view of the new initiatives, the workload in the OE area is showing an increasing trend. The team encourages the plant to look at readjusting resources in the OE area.

Assessment of the OE process at site level is conducted by the Site Operation Review Committee (SORC), chaired by the plant Director. It meets every three months. At unit level, this assessment is also carried out every month in the Plant Operation Review Committee (PORC), chaired by the operation manager and coordinated by the ECM. Lessons learned from the refueling outages are discussed in the After Action Review (AAR) meeting held at a venue outside the plant after an outage.

6.2. REPORTING

FEs are used to report both technical and human performance issues. However, a separate notification process (SAP notification) is used for reporting equipment breakdowns and maintenance reworks. While processing FEs is the responsibility of the PPM department, the individual departments handle notifications.

Recently new initiatives have been started by the plant management to encourage staff to report any minor events.

Well laid out guidelines exist for reporting significant events. However, criteria for minor events are very broad and concept on near misses does not exist. Broad criteria for reporting of events could result in ambiguity for staff and could lead to inconsistence in reporting.

Events are reported to the regulatory authorities as incident reports (RI). The plant also generates reports on technical events that have an added value for OE (REVE) and shares them voluntarily with the regulatory authority.

The plant has a declared “no blame” policy for reporting. A charter signed by top management exists. However this charter is not presently displayed at key locations of the plant as it is undergoing modifications due to the recent management changes. Even though a confidential reporting route exists at the site, very few people are using it. This indicates that communication on this management policy of blame free reporting needs to be enhanced.

6.3. SOURCES OF OPERATING EXPERIENCE

At the plant, internal OE is maintained in the experience form system (FE) and in the System Application Products (SAP) notification database and is readily available to all plant personnel.

Operating experience is also obtained from external sources that include IAEA/NEA IRS, WANO SERs and SOERs, NRC generic letters, Framatom Owners Group (FROG) and Pressurized Water Owners Group (PWOG). Access to the WANO database is available to key management personnel in the plant. However access to the IAEA/NEA IRS database is presently limited to the OE manager in the process and performance management (PPM) department. The plant is encouraged to consider making this access available to other key persons of the plant so that they can have easy access to this important source of international OE. The plant also maintains an external operating experience database that is shared between the Tihange plant and Doel NPP. Thus all OE from its sister units is available to the plant on line. The plant also obtains relevant OE from the conventional plants of the Company through its corporate office. The team recognized this as a good practice.

6.4. SCREENING

All the SAP notifications and FEs of the previous day are screened in the plant daily coordination meeting. This meeting is steered by the ECM. On average, 20 to 30 notifications and 2 to 3 FEs are screened daily. However screening criteria are not documented and events are screened for trending or analysis based on individual experience. In view of the lack of documented screening criteria and the high workload, the possibility of error in the screening of events is likely to occur. The team observed that a recent FE based on the misalignment of valves in the chlorination system had important lessons on human performance but was screened out as a non-significant event to be used for trending only. In order to prevent the recurrence of such a missed opportunity to learn, the human performance section manager has issued directives on this for receiving all FEs. The plant is encouraged to look at the possibility of conducting the screening of events in a more systematic and detailed way.

Because of the online connection of the external event databases of the plant and Doel NPP, the OE managers of these two organizations mostly carry out screening of external OE jointly. In order to ensure that no relevant external OE is screened out, the team advises the plant to carry out this screening independently and to later compare results.

6.5. ANALYSIS

Analysis of various events is conducted separately in different departments of the plant. The ECM in the daily coordination meeting decides on the type of analysis. He also identifies the department for the analysis of a particular event. Subsequently, the SPOC of the identified department assigns the responsibility of analysis to a responsible person in the involved department. As a consequence, in most of cases, the department in which an event occurs is also responsible for its analysis. The plant may consider introducing an element of independence/ peer check in this analysis process.

During the year 2006, even though a number of events related to human performance had occurred in the plant, root cause analysis was carried out for only one event. One of the reasons for this was a gap of around one year between stopping existing event analysis work and introducing the new setup. However, an independent human performance section has now been established at the plant and this section is in the process of settling down. One of the new initiatives taken by this section is to participate in the analysis of all RIs.

Responsibility for event investigation is spread across individual departments, the human performance section and the OE section. However, very few personnel of the plant are trained in formal root cause analysis. The team observed that event analysis is not conducted in a timely manner and by using formal root cause methodology and hence decided to propose a recommendation on this subject.

6.6. CORRECTIVE ACTIONS

The plant has a very simple and effective method for the prioritization of corrective actions (CAs). It is essentially a visual tool where colours are assigned as per predefined priorities. CAs are followed up in the Unique Action Follow-up database in which colours change when the deadline of the CAs is exceeded. CAs on the internal OE at each unit are followed up in a monthly PORC meeting coordinated by the unit Exploitation Coordinator Manager.

For external OE, each department follows up the implementation of its CAs through the Return of Experience (REX) SPOC. The REX committee carries out an over all (for the whole plant) follow up of the actions, which arise from external OE. CAs arising from the analysis of OE is stored in the Unique Action Follow-Up database. It is possible to search this database for the corrective actions completed, actions in progress and actions that are behind the due date of completion. It was observed that a number of CAs have gone beyond their due date of completion. However, there is a downward trend now in this backlog. CAs arising out of SAP notifications are maintained in a separate SAP notification database.

The quality and audit section carries out a sample check on the implementation of the CAs. Once every three months, the Chief Executive of Electrabel reviews among other things the OE programme of the plant with a focus on the corrective action programme. The team found this practice of involvement of top management in the OE process very good and worth emulating.

6.7. USE OF OPERATING EXPERIENCE

Use of operating experience in personnel work activities like pre-job briefings; work planning, shift briefings etc. has just started at the plant. However the concept of OE in these practices is still limited to lessons learned from the same work performed last time. Operating experience from the external events, especially from international events, is not currently used in pre job briefs. The team made a suggestion on this subject.

6.8. DATABASE AND TRENDING

All the FEs initiated in the plant are screened by the ECM and then forwarded to the PPM section for inputting into a REX database. The FEs are then transmitted through a mail system to the individual departments for analysis. Facility for an exhaustive search through a large number of key words is available. Trending reports on the status of pending analysis in various systems can be generated through this database. The trend reports are reviewed annually and adverse trends are followed up. This system is working well at the plant.

6.9. ASSESSMENTS AND INDICATORS

The plant conducts assessment of the OE process through two different routes. The REX committee meets once a year to exclusively review the effectiveness of the plant OE process. This review process has been in place for the last two and half years. However, a few months back the plant has also initiated a parallel annual self assessment in which the PPM manager conducts a review meeting once a year to see the effectiveness of the process. Results of these assessments are well documented and integrated with the plant corrective action programme. However, as the self-assessment process at the plant is quite young, it needs to be nurtured and followed-up effectively. A number of indicators are used to track the effectiveness of the OE programme. These include analysis and CAs completed, analysis and CAs pending implementation, etc. This programme is running well at the plant.

DETAILED OPERATION EXPERIENCE FINDINGS

6.3(a) Good practice: Operating Experience Feedback with operators from conventional plants.

All conventional and nuclear power plants of Electrabel are part of a network that shares information and experience related to equipments, organization, etc. The events that are addressed can be related to technical issues, human performance, health & safety and the environment. Operating Experience (OE) from all entities comes from various sources, including the Maintenance Competence Center, working in both conventional and nuclear generation.

The ensuing internal OE is formalized and made available to all sites in a common language (English). A point of contact is given on each report for additional information. Each plant analyses this OE and assesses the possibilities of incorporating it into its own organization. This specific way of experience feedback was implemented two years ago with about 15 reports per year. Out of them, 50 percent were used for analysis at the plant.

As an example, the plant received OE from the Maintenance Competence Centre (MCC) of Electrabel on the wrong operation of a high voltage circuit breaker. The MCC's recommendation was to open and close these circuit breakers using the pushbutton switch in test position after the disconnection of the low voltage but before removing the circuit-breaker from its compartment. This OE was used for analysis in Tihange NPP and led to the modification of the Operator's Handbook.

With this type of feedback from the conventional plants, the plant is able to improve its performance, especially in conventional areas like electrical systems, turbine generators and cooling towers. This could in turn help to improve nuclear safety as some of these systems or components may be involved in giving supply to nuclear safety systems.

6.5(1) Issue: Events are not always analyzed in a timely manner and by using formal root cause analysis methodology.

The team found the following facts**:**

- On 19 April 2007, while testing iodine filters, an INES (International Nuclear Event Scale) level 1 event involving release of iodine activity directly into the stack occurred at unit 2. The third meeting on the analysis of this event, held in the plant on 14 May 2007, concluded with an action item of conducting interviews of the shift staff involved in this event. Such delay in gathering evidence, especially in events involving shift personnel and their interface with the contractors, could result in loss of/inaccurate information about the event due to memory lapses, and subsequent inappropriate corrective actions.

- Presently, the plant uses a "fact tree" as a tool for root cause analysis of events. This methodology, as used, covers only the collection of facts regarding "what" happened and does not address the "why" part of the analysis in detail. The lone event on human performance issues, analyzed in 2006, involved leakage of water from the reactor vessel head during boxing up after refueling outage. This event resulted in the generation of 10 tons of liquid waste, over exposure of 6 workers and 9 hours delay in the reactor start up. The identified cause of the event was the illegible indication of water level in the reactor pressure vessel. Corrective actions were suggested accordingly. However, the plant has been living with this problem for many years, which is a deficiency in management oversight. This was not captured in the analysis and it was stated that the plant is planning to address such issues in future root cause analysis.
- On 13 September 2006 there was an event involving fire in the electrical cabinet in unit-2. Safety related ventilation fan motor was running with its fan in the blocked condition. As a result, higher current was taken by the motor, causing melting of the overload device and subsequent fire alarm. The analysis report on the event indicates no corrective actions were required. However, one reason for the occurrence of the event was the negligence of the operator in acknowledging the over load alarm in the control room. The analysis report neither addressed this issue nor looked at the cause of fan blockage.
- On 4 May 2007 misalignments of valves in the chlorination system in unit-1 resulted in unsuccessful chlorination attempts in the condenser cooling water system. Even though the event involved human performance issues and loss of production, no analysis was carried out and it was treated as a non-significant event and was included in the database for trending only.
- Individual exposures of workers that exceeded the planned back-out dose are available in the DOSIVIEW system, but root cause analyses of these anomalies are not performed in a systematic way.

Lack of in depth analysis and delay in event analysis may lead to inappropriate root cause findings, resulting in corrective actions that may not prevent the recurrence of events.

Recommendation: Events should be analyzed in a timely manner and by using formal root cause analysis methodology.

IAEA Basis: NS-R-2; 2.21: Operating experience in the plant shall be evaluated in a

systematic way. Abnormal events with significant safety implications shall be investigated to establish their direct and root cause. The investigation shall, where appropriate, result in clear actions with undue delay. …
NS-G-2.11; Appendix III.7 : The on-site investigation should be commenced as soon as practical to ensure that information is not lost or diminished and evidence is not removed. …
4.7: Event analysis should be conducted on a time scale consistent with the safety significance of the event. …

6.7(1) Issue: Plant management does not always actively reinforce the use of operating experience throughout the plant to effectively improve plant safety and equipment reliability.

The team found the following facts:

- At the plant, use of operating experience in pre-job briefs is limited to lessons learned from the same job previously performed. Operating experience from external events, especially international events, is not currently used in pre-job briefs. Examples on issues with the pre-job briefs are given in MOA area.
- A radiation survey was performed by a contractor on the roads of the site on 30 September 2006. The survey focused on the possible contamination of roads (outside of the Radiation Controlled Area (RCA)). As a result, suspected contaminated points were identified. The area was cleaned but no report on such a significant event was prepared. Thus, the opportunity for using this vital operating experience was missed. International experience was not used to prevent this event.
- A very broad criterion for reporting of non-significant and minor events exists at the plant. The operating experience (OE) guidance document defines "all the events that do not affect the operation of the plant" as minor events and the concept of near misses does not exist in the OE documents. The expectation on reporting of events is that "all events should be reported." Such broad criterion could result in ambiguity for staff and lead to inconsistency in reporting. The criteria for screening of events are also not documented.

Without the effective use of operating experience it is difficult to reduce the occurrence of significant events.

Suggestion: The plant management should consider actively enforcing the effective use of operating experience throughout the plant to improve plant safety and equipment reliability.

IAEA Basis: NS-G-2.11: 7.2: Managers of nuclear installations should clearly define their expectations regarding the systematic reporting, screening and use of internal and external operating experience. Information on operating experience should be made readily accessible to plant personnel. For example, licensees should issue information relating to operating experience (e.g. in the form of a synopsis of past events, team briefings, work briefings, so-called just in time (JIT) information about events that have occurred elsewhere under similar plant conditions, and lessons learned) when assigning plant work. In this way personnel are reminded of previous problems that have occurred locally and at other locations and that are relevant to the plant on which they are about to work. Effective use of the feedback of operational experience should be actively encouraged and reinforced by plant managers and supervisors, including the use of operating experience in refresher training for plant personnel.

7. RADIATION PROTECTION

7.1. ORGANISATION AND FUNCTIONS

The radiation protection programme at the plant is well structured and developed in documents and procedures. The basic radiation protection limits are based on the country's legislation and a set of administrative dose limits per day, week, month, year and for outage are included.

The plant has defined a radiation protection policy with key performance indicators, goals and objectives. They are well known and followed.

Responsibilities are clearly defined. The radiation protection group is within the "Care" department. It consists of a logistics group, methods group and an intervention group. Staffing is adequate, and additional radiation protection workers are hired to support activities during an outage.

Radiation protection performance indicators are established and followed. The collective effective dose is defined as a key performance indicator. However some performance indicators are not used in a systematic way with in-depth analysis. For example, skin contamination cases at the IPM9 monitor are only gathered and documented. Individual exposures of workers that exceeded the planned back-out dose are available in the DOSIVIEW system, but root cause analyses of these anomalies are not performed in a systematic way.

An ALARA (As Low As Reasonably Achievable) committee is established at the plant. ALARA principles are defined. Pre-defined values of the collective effective dose calculated in the radiation job planning system are used for ALARA screening.

Radiation protection (RP) group is well utilized and are independent from the operational and maintenance departments. The budget and resources available are sufficient for radiation protection activities and services.

Radiation protection personnel are involved in drawing up operational and maintenance procedures. Annual reports are developed and data are evaluated. Outage data are collected, analyzed and documented. Performance indicators are defined and used e.g. collective effective dose, annual gaseous as well as liquid releases. These specific key performance indicators are followed and reported in a timely manner.

Activities associated with radiological hazards are planned within the scope of work order preparation. Qualification of the personnel is adequate. Radiation protection personnel have specific training prepared according to needs and specific to their functions.

There is a training facility with mock-ups of some radiation controlled area (RCA) equipment such as pumps, electrical cabinets, tanks, RP monitoring devices and hot and cold change room at the plant. The facility was put in operation approximately a year ago and is used for practical training sessions. Up to now, three scenarios for RCA job training were developed and are in use and another one is at the preparation stage.

There is a training programme for radiation workers at the plant. There is one training programme for Electrabel workers and another for contractors. The basic training contains three days of classroom training on basic radiation protection and one day is dedicated to practical sessions. Two hours' classroom refresher training is provided to the radiation workers annually, but no practical part is included. Requests for specific focus in the refresher training from radiation protection department are respected. The content of the file of the training itself (Power-point file) is comprehensive.

Medical examination for entry to the RCA is required and the general medical services are in charge of the examination. The frequency of the health examination is every 6 months. Qualified medical assistance at the site is available as needed.

7.2. RADIATION WORK CONTROL

Radiation work permits are not used at the plant. As a substitute, radiation protection activities are included in the work order planning process. But activities of some operating personnel, such as chemistry, radioactive waste handling and operation are not included in the work control process (WCA) planning. Therefore, some jobs with higher radiological risk could be omitted. Radiation job planning is performed within the WCA process with the usual specific radiation protection measures. For example, the electronic personal dosimeter (EPD) pre-set alarm is based on a dose estimate. But the time limit for these jobs is not used and the EPD is the last barrier for worker dose control. Workers are required to back out in case of a EPD alarm. If the EPD gets broken, no more barriers for worker protection exist. There also observed cases when radiation workers skipped radiation protection assistance and the work was performed without RP assistance. The team developed a recommendation in the Operations' area.

Access points to the RCA is via “cold” change rooms where personal clothing is taken off and “hot” change rooms, where working clothes and necessary PPE are put on. Unauthorized entry is avoided by personal identification and examination of whether the person is in the database of authorized radiation workers. During the exit from the RCA, second identification of every worker is performed using their film badge.

Exit monitors from hot change rooms are adequate and sensitive enough. Moreover these monitors are able to measure not only beta contamination but also gamma radiation and so they are also able to detect internal contamination of the monitored worker. Personnel external contamination monitoring is effective and the minimum detection level corresponds to the requirements of the country regulatory body. Exit monitors at the exit from the RCA to the “hot” change room are almost obsolete and studies for its replacement are underway.

Storage of contaminated tools in the RCA is in the room dedicated for tool storage and in metal cabinets. Contamination monitoring is expected to be performed by workers themselves. The RP personnel do not perform independent contamination surveys of the tools already stored. Also contamination control of vacuum cleaners is not done on a systematic basis.

Workers moving from contamination zones and out of the RCA, follow RP procedures. They perform monitoring and frisking at the zone boundary. Nevertheless, the team observed some deficiencies in this activity and the team developed a recommendation in this area.

The radiation survey programme is comprehensive and performed according to plant procedure. It is executed in a systematic way within the time schedule. Results of the survey are stored and archived. Internal exposures are followed by exit monitors from the RCA. The detection level is sufficient to detect small internal contamination intakes.

Posting of zones in the RCA is carried out according to the plant procedure. Doors to rooms are labeled with information on ambient dose rate, hot spots, and contamination. Also “waiting areas” are well defined and easy to recognize. The posting and zoning procedure is in compliance with international standards, nevertheless the team observed that some labeling and posting information was insufficient and the team made a suggestion in this area.

7.3. CONTROL OF OCCUPATIONAL EXPOSURE

Radiation protection is optimized. The ALARA procedure is implemented at the plant. The assumed collective dose is used as a criterion for ALARA planning. The dose is calculated from the predicted time of the job, the dose rate at the place and the number of individual workers. But the individual dose is not used as a criterion in the process.

A collective dose planning system is used at the plant. If the calculated collective effective dose exceeds 0.5 man mSv during outage, specific protection measures are planned and implemented**.** For example, shielding, tele-dosimetry, communication means, proper lighting, a proper set of Personnel Protective Equipment (PPEs) are frequently well used.

The estimated dose is evaluated for every pre-planned maintenance radiation job and added on a daily basis. If the sum reaches 75% of the estimated dose, the maintenance department in charge is informed and intervention is suspended. The “ESTER” database is used for the purposes of dose evaluation. In the database the necessary data on rooms, room equipment, pictures, maps and drawings, radiological signs, hot spots, dose rates, temporary and permanent shielding etc., are stored. The database is available via intranet and is widely used. The team recognizes this as good performance.

Permanent shielding of equipment with high dose rates is utilized, as well as detachable lead blankets that are fastened to a frame construction. In this way, workers' personal doses are reduced significantly. This use of detachable shielding is efficient and simple and the team identified it as good practice. As a target value of the collective effective dose (CED) for this year a limit of 1300 man mSv was set and the trend of CED has been decreasing in the last three years.

The internal contamination monitoring programme is well developed. It is performed in two ways. The first is at every IPM9 exit monitor, where beta whole body contamination is usually measured, gamma radiation is also detected. This simple and effective solution enables the detection of internal contamination of radiation workers at an early stage. The team recognizes it as good practice.

The second monitoring is whole body counting by a germanium detector gamma spectrometry performed twice a year. Periodic internal contamination monitoring of radiation workers is carried out by the medical service. The internal dose recording level is 200 microSv, when the external dose recording level is 100 microSv.

Appropriate dosimetry of external irradiation is provided for all radiation workers. Workers are provided with proper external dosimeters. Film badge and electronic personal dosimeters (EPD) are used. The legal dosimeter is the film badge. Film badge dosimeters are evaluated on a monthly basis and EPDs are evaluated at every exit from the RCA. Adequate standards are used for equivalent dose measurements. The correct quantities for personal dose equivalents Hp(10) and Hp(007) are used for external dose monitoring as required by ICRU

(International Commission on Radiation Units and Measurements) documents and ICRP (International Commission on Radiological Protection) documents. The number of EPDs is satisfactory for outage and in case of an emergency.

Dose tracking of NPP workers as well as contractor workers is good. This dose tracking is performed in the DOSIVIEW database.

7.4. RADIATION PROTECTION INSTRUMENTATION, PROTECTIVE CLOTHING AND FACILITIES

Portable and fixed dose rate and contamination measurement instrumentation is available in sufficient numbers, ranges, and categories. It is dedicated to use in normal operation, anticipated anomalies as well as in an emergency.

For control of contamination of personal protective equipment which has been washed, specific automatic belt and overall monitors are used. The pre-set contamination limit values for washed Personnel Protective Equipment (PPEs) should be consistent with other surface contamination limits. Variety and sufficient range of personal protective equipment is available.

Gaseous and liquid effluent monitoring equipment monitors normal effluent release paths continuously and is periodically calibrated and tested. Measurement ranges are satisfactory for normal as well as for emergency monitoring. The liquid effluent monitor automatically closes the valve on the discharge line if a pre-set limit value is reached.
Radioactive release monitoring instrumentation and equipment are appropriate for emergency situations.

Temporary storage of solid radioactive waste (SRW) is available. For SRW with high radiation risk, a contact dose rate above 2mSv/h, shielding containers are used for temporary storage. A decontamination workshop is in use in the plant. Decontamination pits are well prepared.

7.5. RADIOACTIVE WASTE MANAGEMENT AND DISCHARGES

SRW is collected and appropriately sorted into combustible and compactable. Potentially clean wastes are collected separately. A procedure for waste clearance is in place. Unnecessary material is cleared out from the RCA in order to decrease the amount of potentially radioactive materials. Quality assurance and quality control procedures of the process are in place.

Conditioned radioactive waste (dose rates <2 mSv/h) is transported by lorries to another facility. Pre-treated radioactive waste (dose rates >2 mSv/h) is transported for additional treatment to another facility.

Tools and other material are shared between three units at the site. It is desirable to minimize transportation of contaminated material in order to prevent the risk of spread of contamination. SRW and tools are transported in metal transportation containers in accordance with the plant procedure. The team found some deficiencies in the area and encourages the plant to identify possible weak points in existing procedures for radioactive material transportation and clearance, to revise the procedures and to ensure their strict and proper implementation and verification.

Radioactive material is cleared from the plant RCA by using two "CONDOR" monitors. The monitors are annually calibrated with quarterly test and checked at a daily basis or at least before the measuring campaign. The test is done using an authorized reference radioactive source according to plant procedure. An authorization form is filled in and then archived. If the result of the authorization is unsuccessful, the CONDOR monitor is declared out of operation and the RP personnel is informed. When checking authorization sheets, the team found that on 3 May 2007 and 4 May 2007, the authorization was not filled in due to procedure revision. At the same time, the logbook of cleared items from the RCA declared that for these two days more than 35 items were cleared out of the RCA. The team strongly encourages the plant to perform daily verifications.

Gaseous and liquid effluents are low and a decreasing trend has been seen in recent years. They are kept below the authorized level. Procedures to control effluent releases are implemented and release records are maintained.

A set of meteorological measurements is utilized and the information is available also in case of a radiological emergency.

Environmental monitoring of the plant is performed by the country regulatory authority, the Federal Agency for Nuclear Control (FANC) within the framework of the state supervision dosimetry network, TELERAD. Annual reports are produced by FANC. As stated in the report, the radiological impact of Tihange NPP operation, on the environmental system in the vicinity of the plant is negligible and not measurable.

7.6. RADIATION PROTECTION SUPPORT DURING EMERGENCIES

Radiation protection emergency procedures have been drawn up and emergency equipment, including KI pills, is available. Radioactivity measuring devices are available and emergency response personnel are trained in the area. Supplies of PPEs are abundant. Dose rate detectors continuously measure at the assembling points in order to have timely and correct information at the places. Electronic personal dosimeters are prepared for emergency response personnel. Two vans equipped with mobile measuring laboratories are in stand-by mode on site. The crew of the cars consists of a driver and a trained technician. Both are available on call. Drills and training sessions of these workers are performed three times per year. The knowledge and skills of emergency workers is satisfactory, but in some areas could be improved. For example, in case of monitoring in the radioactive plume, (recognizing if the monitoring van is in the plume) and detailed knowledge of worker turn-back dose guidance is desirable.

DETAILED RADIATION PROTECTION FINDINGS

7.2 RADIATION WORK CONTROL

7.2 (1) Issue: Plant workers, in some cases, do not follow the plant requirements necessary to prevent their contamination and/or spread of contamination:

- When observing functional tests of the Nardeux monitor at the contractors' changing room exit (for approximately 20 minutes), a group of 25-30 workers were gradually exiting from the RCA to the hot changing room. Six of them measured themselves on the monitor without wearing gloves, when the plant rules require measurement with gloves. A poster is attached to the monitor for reminding the rules. When coached by the counterpart, they pulled out gloves from their pockets. The case statistics for this incorrect behavior was 20-25%.
- 2 workers from the previous group did not measure their personal items and two other workers did not measure their personal items when exiting the RCA.
- When observing a radiation job in room number N130, the worker performing a repair on valve RBR V006DS did not use a protective glove on his left hand.
- Temporary waste storage in room E332 was observed with open bags and some contaminated items were directly laid on the trolley.
- 2 workers were seen without gloves in the RCA.
- A cable after decontamination was not properly wrapped in its plastic bag, with one half in the bag and the other half out of the bag.
- Some devices were transported from the RCA to Unit 2. The driver took the accompanying transportation document fastened to the transport bag with his bare hands.
- Another random survey was executed in the maintenance tools storage room with the following results. A bucket was on the floor with a floor cloth inside it. Contact dose rate on the floor cloth was 5 microSv/h and the contamination detector indicated more than 100 Bq/cm2. A small ladder on the floor was detected as being contaminated and one smear result was 2 Bq/cm2 and the second one was 100 Bq/cm2, while the plant rule prescribes for these areas a contamination limit of less than 4Bq/cm2.

Inadequate worker behaviour, as well as lack of attention to daily activities, increase the risk of personnel contamination and/or the spread of contamination.

Recommendation: The plant should take appropriate measures to ensure correct contamination prevention and correct worker behavior in the field in order to prevent their contamination and/or the spread of contamination.

IAEA Basis: SS115 Appendix 1: 1.10. Workers shall:
(a) follow any applicable rules and procedures for protection and safety specified by the employer, registrant or licensee.
(b) use properly the monitoring devices and the protective equipment and clothing provided.

7.2 (2) Issue: Existing plant procedure on posting and labeling is not fully implemented on non fixed equipment so staff working in the radiation controlled area is not always provided with the appropriate information on specific radiation risk.

The plant develops a procedure and a posting system for delivering information on premises and systems. The team recognizes that as consistent with international standard. However, a complementary survey shows:

- A radiation warning sticker was on a metal cabinet with an indication of 30 microSv/h. When discussing the zoning question, the team found that the source of radiation was a pump wrapped in a plastic bag with a contact dose rate of more than 1 mSv/h. In that case, according to plant procedure, the equipment should have been decontaminated or posted as "hot spot".
- Transport containers are used to transfer solid radioactive waste (SRW) in plastic bags and are stored at the SRW storage place in room N393. Some containers were locked, some were unlocked. No information was posted about the surface dose rate of the containers, and the bags themselves were not measured and labeled. The area was not secured and information on the dose rate was not provided.
- In room N393, a chain dividing the transportation area (close to the gate out of the RCA) from the normal RCA area, is in place, with posted information. The objective was to prevent spread of contamination from the RCA to the transportation zone. However, it was observed that the chain and the posting information were not in place and the transportation area was freely accessible.
- Long steel bars and metal plates were wrapped in a plastic sheet in the spent fuel pool area. One of the sheets was cut and opened and none of the packaging had a radiation warning sticker, as is requested for contaminated items in the plant procedures. It was not clear which material is contaminated and which is not, and what the values of the contamination are.

Without proper, clear, accurate and timely information (chains, posters with dose rate information, dates, etc.) awareness of the worker could be diminished and doses of radiation workers could not be kept ALARA.

Suggestion: Existing plant procedure on posting and labeling should be considered to be fully implemented on non fixed equipment so that staff working in the radiation controlled area be always provided with the appropriate information on specific radiation risk.

IAEA Basis: NS-G-2.7; 3.8: Warning symbols such as those recommended by the International Organization for Standardization (ISO) and appropriate information (such as radiation levels or contamination levels, the category of the zone, entry procedures or restrictions on access time, emergency procedures and contacts in an emergency) are required to be displayed at access points to controlled areas and specified zones and at other appropriate locations within the controlled area (Ref. [2], para. I.23). Persons crossing a zone boundary should be made aware immediately that they have entered another zone in which dose rates or contamination levels, and thus the working conditions, are different.

7.3. CONTROL OF OCCUPATIONAL EXPOSURE

7.3(a) Good practice: Fixed structures for non permanent lead shielding blankets.

The plant has designed and installed seismically qualified fixed structures on which blankets of lead shielding can be quickly installed and dismantled for high dose rate worksites in places where workers go to carry out systematic maintenance activities.

As a result, there is a considerable saving in individual and collective radiation exposure at each outage, resulting in the following advantages. There is no longer any need to bring, install, accept, dismantle and remove scaffolding to install shielding on these worksites. The fixed structures allow shielding to be installed earlier in an outage. It is quicker to install and remove shielding thanks to the geometry of the specifically designed structures. Since the radiation exposure incurred by the installation of this shielding is low, it is worthwhile applying even for short jobs as implementation of ALARA.

An additional advantage is that very little investment is required for these fixed structures. This practical approach is easily applicable even in seismic qualified plants because of its ergonomic design and savings in terms of dose and investment.

7.3 (b) Good practice: Integrated Detection of Internal and External Contamination.

The plant has equipped all exits of its radiological controlled area with sensitive exit gate monitors "IPM9" that are equipped with beta and gamma detectors. Beta detectors monitor worker skin contamination at the level of legal requirement.

The purpose of the gamma channel is to monitor worker internal contamination and detector sensitivity is sufficient to detect internal contamination of the monitored worker lower than or equal to 1% of the annual limit of intake of the most important radioisotopes of interest.

An internal contamination is recognized from external contamination if, after decontamination of the worker's body, the monitor detects only gamma contamination or if the whole body contamination monitor indicates contamination of the respiratory and digestive traces. In this way, all radiation workers at the plant are systematically checked after every visit to the RCA for external as well as internal contamination. The short monitoring interval makes it possible to detect intakes of radioactivity promptly at acceptable detection levels.

Additionally all external radiation workers arriving on site are controlled at the entrance by 2 IPM9 monitors.

The practice is performed independently from internal contamination monitoring of radiation workers performed twice a year by the authorized medical services using whole body counter with a germanium detector.

This practice enables worker intake of internal contamination to be well detected at an early stage.

8. CHEMISTRY

8.1. ORGANIZATION AND FUNCTIONS

The chemistry service is part of the operations department. The chemistry service manager is under the direct authority of, and reports to, the operations department manager.

Generic and specific responsibilities of the chemistry service organization as well as interfaces with other plant groups are included in the procedure „Organization of operation department chemistry service at Tihange NPP'' (CHIRAD/00/012). The interfaces with different plant groups are well-described and well-managed.

In the chemistry service organization there are four laboratories: three operational laboratories (one for each unit) and one common laboratory for environmental monitoring, interfacing with external laboratories, maintenance contracts, commissioning of new instruments and development of new analytical methods.

Safe chemical operations are ensured at all times by permanently staffing the chemistry laboratory with shifts of skilled personnel. The shift chemical technicians are in charge of chemistry control of plant systems, monitoring of chemical conditioning and the production of de-mineralized water.

Specifications, suggested monitoring frequency and corrective actions to guide chemistry and operation staff in a satisfactory chemical operation of the plant are included in the plant chemistry specification procedure. Multi-step action levels and corresponding actions are well-defined both for primary and secondary water chemistry.

No contractors are on site for performing chemistry current control activities. Nevertheless, good support from external laboratory (Laborelec) has been seen for chemistry data evaluation, analytical procedure updating and personnel training. The team encourages the plant to continue this practice. There is no formal job rotation for the personnel but common laboratory personnel have the necessary knowledge and skills to replace the shift technicians if needed.

The chemistry manager participates in the daily operation department coordination meeting where plant status and main activities of the day are discussed. Essential chemistry parameters are included in the "Daily Report - essential parameters of chemistry" document. This is annexed to the daily coordination report.

The chemistry manager displays a positive attitude and it is evident that a good and very professional relationship is maintained between the chemistry staff and other department staff.

Annual objectives are established at department level and disseminated to the personnel. These are posted in work places and the personnel is aware of their role in achieving these objectives.

Chemistry practices applied are in compliance with specifications and consistent with internationally accepted good practices.

Water chemistry criteria and specifications during normal operation, start-up and shutdown periods, including lay-up conditions, are well defined in the procedures CHIRAD /00/013 and CHIRAD/00/024.

All the administrative interfaces between chemistry service and other groups are clearly established, understood and effectively used by the staff. Nevertheless, both chemistry and operation groups are encouraged to improve the communication between the chemistry laboratories and the main control room.

A set of performance indicators has been recently developed to monitor chemistry control performance and measure its effectiveness. Targets and colors have been assigned to each threshold value and when the indicator does not meet the target, corrective actions are established and should be reported the next month. However, the chemistry control programme is not sufficiently supported by other specific indicators such as availability of laboratory instruments or on-line monitors. Failure to consider some specific indicators could lead to an incorrect evaluation of the chemistry control programme and inferior practice. The team made a suggestion in the MOA review area that refers also to chemistry performance indicators.

Training and qualification requirements for new employees in the chemistry service are included in the procedure RH/FORTEC/0/Z/017. Nevertheless, there are no job related training requirements developed for each position. Annually, an on-the-job training (OJT) programme for chemistry personnel training is issued. Chemistry personnel must also attend annual refresher training for radiological protection, industrial safety and fire protection. Nevertheless, this is a two-hour course which only 10 % of the chemistry personnel have done at the time of the OSART visit. The chemistry management is encouraged to look for a better planning of personnel that should attain this course. Only chemistry procedures are used for chemistry personnel OJT. Training materials with clear objectives and expectations are not well developed to date. There are no qualified training instructors available to support chemistry personnel OJT. The chemistry service management monitors the staff’s qualification performance. However, no specific performance indicator has yet been developed. The team made a suggestion in the TQ review area which also refers to chemistry training.

8.2. CHEMISTRY CONTROL IN PLANT SYSTEMS

The coordinated lithium/boron chemistry used during normal operation effectively preserves the integrity of primary circuit components and fuel cladding over the design lifetime of the plant. Injecting isotopically pure Li-7, considerably reducing tritium production, ensures the appropriate pH value in the primary coolant. Following the replacement of the steam generators, the chemical conditioning of the primary circuit was changed to obtain a pH of 7.1 measured at the functioning temperature of the primary circuit instead of 6.9.

The generation and transport of radioactive products within the nuclear systems are considered, controlled and minimized by optimizing the chemistry conditions in these systems.

The concentration of dissolved hydrogen and boron within the primary circuit are continuously monitored by on line analyzers, displayed and recorded in the chemistry

laboratory.
Secondary chemistry is based on ammonia all-volatile treatment. Water chemistry effectively contributes to good steam generator material condition and prevents tube damage by maintaining a low corrosion rate in the secondary systems. For secondary circuit chemistry control the plant does not use a polishing condensate system. Nevertheless, the values measured for steam generators' contaminants are well below the action levels limit indicated by plant procedure CHIRAD/00/013. The use of external experience is not evident in that area since an old revision of the Electric Power Research Institute (EPRI) guideline for water chemistry is referenced.

Secondary side steam generators water lancing is performed during each planned outage. However, an inspection is performed only after the water lancing to check for foreign materials. Sludge is evaluated only by weighing removed material and the team encourages the plant to benchmark to develop a more accurate programme.

To control secondary chemistry during start-up, a hold point at 40% full power is established in the chemistry control specification procedure. The review of the current fuel cycle start-up shows compliance with this hold point. However, the plant is encouraged to better identify the source of high level sulfate measured during start-up.

The chemical treatments for the emergency cooling circuits, auxiliary circuits and makeup water production are appropriate to ensure the requested water quality.

To prevent the biofouling in the cooling circuits, the plant applies an efficient bleach treatment. Several criteria have been established and are trended by the plant to monitor the efficiency of this treatment. Analyses are carried out by specialized external laboratories to monitor the biological species from the cooling water in order to better assess the efficiency of the treatment. This was recognized by the team as a good performance.

The team found that the revision process of chemistry control procedures is not sufficiently focused on operation, industrial and nuclear safety issues and proposed a suggestion in that area.

8.3. CHEMICAL SURVEILLANCE PROGRAMME

The chemistry surveillance programme is developed on the basis of the chemical control programme. Daily data sheets that contain routine measured chemistry parameters as well as other important parameters, for example standard solutions measurement results, are developed for personnel use. The results of the analyses are logged into a database enabling a trend follow-up and periodic reporting.

The plant is equipped, on both the primary and secondary sides, with on line analyzers for monitoring the main chemistry parameters. The records from these are displayed in the cold chemical laboratory for the chemistry shift personnel awareness. This ensures a good follow up, when the laboratory analysis verifies the trends shown by the on-line analyzers.

Satisfactory analytical procedures are easily accessible in the chemistry laboratories. Nevertheless, some space exists for improvements in this field. To perform an analytical methods revalidation, the plant request Laborelec (ISO 17025 accredited) support.

Some quality control procedures exist. However, quality control practices are not improved enough by the chemistry management to support an effective quality control programme in order to increase the confidence of chemistry personnel on control of activities. The team suggested the chemistry management to consider improvement of the actual control programme and practices.

Each year, the chemistry section performs an internal comparison based on a programme developed in advance and included in a chemistry procedure. To increase the confidence of these tests, the samples are provided by an external company. Every month, two samples are analyzed randomly by the shift technicians and by the common laboratory technician.

Every three years an external comparison organized by the regional nuclear authority takes place. Using the results, the Authorized Inspection Organization, Association Vinçotte Nuclear (AVN) submits a report as well as corrective actions if deviations of these results exist.

8.4. CHEMISTRY OPERATIONAL HISTORY

Primary and secondary chemistry control parameters are followed throughout each fuel cycle.

Control data are stored on paper and on the computer database. However, the paper records are not considered permanent records and are stored for only five years.

Trends are available for chemistry personnel by using the input from the chemistry database. The plant has considered further improvements in that area and a new laboratory information management system (LIMS) will be implemented. LIMS will enable more extensive management of activities concerning chemistry within plant systems by linking with the plant's computerized system.

For each fuel cycle the chemistry service prepares a report that includes the important chemistry information in the reported period as well as trends of the chemistry parameters throughout the fuel cycle.

The chemistry personnel have the appropriate skills to enter or to display data from the database, including trends.

8.5. LABORATORIES, EQUIPMENT AND INSTRUMENTS

The chemistry laboratory consists of a hot laboratory situated in the nuclear zone and a cold laboratory outside the nuclear zone. The gamma ray spectrometry counting room is situated between each of these laboratories but outside the nuclear zone. This location is very convenient.

The chemistry laboratory of each unit is equipped in the same way, so as to ensure redundancy in the event of malfunctions or problems of the analytical instruments. Although redundancy and contracts for laboratory instruments maintenance exist, the plant is encouraged to improve this area by supporting chemistry control and effective ALARA principles.

Good housekeeping has been noticed in the chemistry laboratories. The fume hoods are equipped with pressure drop indicators and materials are not stored inside.
The laboratories are equipped with safety showers and eye washing facilities.

A micro-pipette calibration system has been implemented after operating experience feedback from Tihange 3. Deviation in the tritium activity readings was noticed when the analysis showed that the reading error was due to a deviation in the volume dispensed by the micro-pipette. The team considers this as a good practice.

A post accident-sampling system is available for water analysis. With respect to ALARA principles, the system had been modified to install a hypodermic sample. Syringes are used to obtain 1, 0.5 or 0.1 ml samples instead of 20 ml as with the previous system. By appropriate valves line-up, samples are currently analyzed once a week from the primary circuit and compared with the primary circuit sample (from the sampling system). Shielded container and procedure are available for sample transport to the laboratory for analysis.

8.6. QUALITY CONTROL OF OPERATIONAL CHEMICALS AND OTHER SUBSTANCES

An approved chemicals list is available for plant personnel's use. The accepted materials are listed and updated by the Care department in consultation with the chemistry service. Material safety data sheets are available and easily retrievable in the plant network. Appropriate storage conditions for chemicals in the warehouse were noticed. All drums and bottles were stored on berms to collect potential leakage.

Although cabinets are provided for chemical storage in working places, the plant is encouraged to better manage the routine control check in that area.

The CHIRAD/00/O/Z/017 procedure defines the specifications that should be met by chemicals and materials for plant use. Maximum allowable concentrations for halogens (chloride, florid) and sulphur are indicated according to chemicals/material usage.

Bulletins of analysis indicating impurity content as well as isotopic abundance are available for substances used in the primary circuit.

Fuel diesel analysis is submitted for plant acceptance prior to oil fuel delivery to the plant.

Receipt of bulk acid, caustic, hydrazine solutions and boric acid is described in procedures and well managed.

Flammable reagents in the chemical laboratories are stored in small containers and appropriate cabinets. Poisonous substances are stored in dedicated closed cabinets. However, a routine control to check the inventory of those chemicals is not formalized.

A matrix containing the risks of chemical incompatibility, together with the labeling procedures, is indicated in a chemistry procedure and in the plant booklet. The team considers this as a good practice and encourages the plant to extend the use of this matrix to the plant level.

DETAILED CHEMISTRY FINDINGS

8.2. CHEMISTRY CONTROL IN PLANT SYSTEMS

8.2(1) Issue: Revision process of chemistry control procedures is not sufficiently focused on operations, industrial and nuclear safety issues:

- Plant chemistry control procedure, CHIRAD/00/013, has been revised to include some modifications for chemistry parameter values. However, a one-month delay had been noticed between the technical specifications and the CHIRAD/00/013 revision and in the case of I-131 excursion the specifications would be exceeded.
- The new revision of the CHIRAD/00/013 procedure included modifications for steam generators, primary to secondary leak specifications which dropped from 80 to 24 kg/h. Even though it is written in the Technical Specifications, no references are written in the Chemistry procedure in the event of the value being reached or a reference to another plant's procedure.
- EPRI guideline (Electric Power Research Institute – EPRI) for water chemistry is referenced in the procedure CHIRAD/00/013. Currently the revision 6 of the guideline is available, the procedure refers to revision 4 to define the specifications for steam generator blow-down impurities (sodium, sulfate, chloride).
- Sampling activities of all nuclear systems are included in one procedure. This could create difficulties when used in the field. However, the expectation to use the procedures in the field was not found in the chemistry section procedures in opposition with the plant expectations.
- Only some chemistry procedures were found to have included awareness for personnel safety when handling hazardous chemicals or active samples as best practice in use. Nevertheless, specific requirements for chemistry procedures content are not written down in one procedure for chemistry personnel use.

Lack of or inappropriate information in procedures (such as current chemistry parameters, industrial safety and radiation protection precautions, etc.) could lead to personnel injury or improper chemistry control, which could have a long term effect on the plant systems.

Suggestion: Consideration should be given by the plant to focus on the revision of the chemistry procedures to take into account necessary changes in operations and industrial and nuclear safety.

IAEA Basis: NS-G-2.5; 2.14: The operating procedures for reactor start-up, power operation, shutdown and refueling should include precaution and limitation necessary for the maintenance of fuel integrity and compliance with the operation limits and conditions throughout the life of the fuel cycle.
DS388: 2.6: The operating organization should provide adequate facilities, sampling and laboratory equipment, and methodological support including water chemistry regime requirements and standards.

2.20: Chemistry personnel should clearly understand their authority, responsibility and interfaces with other groups. In addition, other plant groups should understand the chemistry staff's role in supporting reliable plant operation.
3.2: The operational limits and conditions as well as any other applicable regulatory requirements are required to be taken into account in the programme and are required to be re-evaluated as necessary in the light of experience.

Note: the document DS388 is the draft document of the safety standards on chemistry in NPPs. The safety standards committee already approves the document.

8.3. CHEMICAL SURVEILLANCE PROGRAMME

8.3(1) Issue: Quality control practices are not improved enough by the chemistry management to support an effective quality control programme in order to increase the confidence of chemistry personnel on control of activities:

- Laboratory instruments are not labeled with the most recent and pending calibration data.
- Several control charts had been developed for controlled chemistry parameters; nevertheless at the date of the OSART visit, a procedure how to use the control charts was not available for guiding chemistry personnel.
- Control charts are available on chemistry database. However, the personnel do not consider the distribution of measured values on both sides of theoretical value. For example, more than 6 measurement values, on the same side of the theoretical value on the control chart for boron measurement, have been seen twice in the control chart developed for the last four months.
- Plant internal comparison exercises are performed monthly, based on an annual programme. Samples are analyzed randomly by day and shift technicians. However, there is not yet a systematic process to assess the chemistry technicians' performance.
- Corrections noticed on chemical parameters data sheet, laboratory instruments calibration sheet, laboratory shift log, are done without undersigning.
- Although the expiry date indicated by the supplier was stamped on two pH-buffer canisters, labels to indicate reception date and expiry date were not affixed on them as with other chemicals. This practice is not in accordance with the procedure CHIRAD/00/O/SZ/021, which requires an additional label when chemicals are received from the storage for laboratory activities.
- Logbooks to record history of maintenance instrument are not in place for laboratory instruments.

Shortfalls in quality control practices could lead to inaccurate chemistry results report and/or non-compliance with technical specifications.

Suggestion: Consideration should be given by the chemistry management to improve the actual quality control programme and practices in order to increase the confidence of chemistry personnel on control of activities.

IAEA Basis: DS388: 5.34: Calibration standards and procedures should be available; calibration plan should be used for this reason.

5.35: Appropriate and well maintained instruments manuals and logbooks should be available in the laboratory, and the chemistry staff should be familiar with their contents.

5.36: Laboratory tests, to identify analytical interferences, improper calibrations, analytical techniques and instrument operation. These tests results should be evaluated to determine the causes of unacceptable differences and deviations, taking into account short-term and long-term effects.

Note: the document DS388 is the draft document of the safety standards on chemistry in NPPs. The safety standards committee already approves the document.

8.5. LABORATORIES, EQUIPMENT AND INSTRUMENTS

8.5(a) Good practice: Calibration of micro-pipettes.

The micro-pipette calibration has been implemented after operating experience feedback from Tihange 3. Deviation in the tritium activity readings was noticed when the analysis showed that the reading error was due to a deviation in the volume dispensed by the micro-pipette.

The use of poorly calibrated micro-pipettes can have a significant impact on the quality and accuracy of certain readings which require small sampling volume such as β, γ and tritium metering.

The testing of pipettes is done according to the ISO 8655 standard, by following the CH123 procedure (Pipette calibration instrument: Sartorius 235P-SD scales and Picasso software).

The management of micro-pipettes is described in the CHIRAD/00/039 procedure:

- The micro-pipettes are stored and managed in the common laboratory.
- The unit laboratories have to contact the common laboratory in order to obtain a micro-pipette.
- Each micro-pipette is checked before being released.
- Those micro-pipettes which are in use are checked every 6 months by the common laboratory. In the case of any non-conformity, they are recalibrated according to the manufacturer's instructions.
- The calibration certificates are put in records in the common laboratory.
- The micro-pipettes which are validated are (re)sent to the laboratories and a label is affixed:
    - L1-Valid >"Expiry date" for Unit 1's laboratory,
    - L2-Valid >"Expiry date" for Unit 2's laboratory,
    - L3-Valid >"Expiry date" for Unit 3's laboratory,
    - L0-Valid >"Expiry date" for the common laboratory.

In conclusion, the implementation of this micro-pipette calibration control system provides quality monitoring of the micro-pipettes and supports the quality of analyses.

8.6. QUALITY CONTROL OF OPERATIONAL CHEMICALS AND OTHER SUBSTANCES

8.6(a) Good practice: Incompatibility matrix for storing chemical products in chemical laboratories.

The displaying of the matrix in all storage areas of the chemistry laboratories has brought about quick and seamless improvements in industrial safety and the storage of chemical and/or dangerous products.

The incompatibility matrix for storing chemical products is included in the Memento booklet, nuclear safety and quality expectations. It is also found on each storage cupboard for dangerous products in the chemistry laboratories.

The principles for storing dangerous substances are described in detail in the CHIRAD/00/028 procedure. The incompatibility matrix summarizes in a schematic way the elementary rules for storing chemical products. It is a quick and simple visual tool to know where a chemical product should be stored in relation to the risks pictogram(s) found on its label:

- Chemical products are classified in 6 risk categories:
    - Oxidant
    - Flammable
    - Corrosive – base
    - Corrosive – acid
    - Toxic
    - Harmful / irritant
- Flammable products should be stored separately from others.
- The acids should be kept separately from the bases.
- Harmful / irritant products and toxic products can be stored together.
- If a product has several risk factors at the same time, the following priority must be taken in terms of classification: oxidizing > flammable > corrosive > toxic > harmful/irritant.

9. EMERGENCY PLANNING AND PREPAREDNESS

9.1. EMERGENCY PROGRAMME

The Belgium Royal decree from February 2006 has established the required actions in case of any kind of emergency situation in Belgium. In October 2003, another Royal decree was issued to a specific Nuclear and Radiological emergency. The Ministry of the Interior is in charge of the national policy and has regulated the general arrangements for all kinds of emergencies by defining the local, provincial and national levels of action. According to Royal decree, each municipality and each province must have its emergency plan for all kinds of possible emergencies in their area. Off-site actions are divided into five disciplines: first aid operations by firemen and civilian protection measures; medical and psychological aid; police actions; logistical support and information to the population.

In case of nuclear or radiological emergency (Federal phase) the off-site response is set at the National Crisis Centre (CGCCR) in Brussels that is coordinated by an Emergency Director. This centre operates also as National Warning Point (NWP) for the IAEA, neighboring countries and the European Community Urgent Radiological Information Exchange (ECURIE), in the event of a nuclear or radiological accident in Belgium.

The on-site emergency plan called “Plan d’Urgence Interne” (PUI) follows Royal decrees. All Electrabel Corporate documents concerning health and safety at work mention the on-site emergency plan.

9.2. RESPONSE FUNCTIONS

When, following the procedures, the plant launches an emergency action plan, the control room activates the PUI through the internal Emergency Call Out System (ECOS).

According to the PUI, the emergency staff is composed of a team of 15 people on call each week. There are 5 teams trained in a specific programme. The leader of each team is one of the managers of the plant organization. The emergency team is well supported by at least twelve technicians, one doctor, one nurse, one radiological protection member and one computer expert all also on duty.

The Technical Support Centre (COT), beside the control room, is provided with the indication of the main operating parameters (Safety Parameters Display System – SPDS) and with communication facilities including videoconference connected to the site emergency center (COS).

To ensure rapid access of emergency personnel to the site, when access is limited, specific colored stickers have been developed and distributed for all vehicles of persons having a role in case of emergency and thus being authorized to enter the site. This system enables police on road blocks to identify emergency plan personnel and allow them to pass through. The team recognizes this as a good practice.

In order to ensure that the corporate crisis organization teams are informed right from the beginning of the crisis, efficient rapid call-out systems at the plant and corporate levels are used to deploy all local and Corporate crisis teams. To assist local communication people, who will be overloaded in case of crisis, a communication team is set up at corporate level to ensure that pro-active and consistent messages are conveyed and all press messages or messages from external parties are monitored and analyzed. Different means of communication exist depending on the type of public: automatic messages for public authorities, a crisis press center for the media, internet and a call center for the general public and internal news for company personnel. All technical information is provided by plant emergency team manager.

During day working hours, a doctor and nurse are available on site. In case medical or fire fighting assistance is needed, the control room contacts the fire department on the other side of the road, through a hot line telephone. The team had opportunity to follow the process during a real medical event occurred the OSART mission. The fire fighting vehicles and ambulances will be guided on site by the blue flashing lights to reach the exact meeting point. A member of the first response team rolls out a tape from the meeting point to the actual location of the accident. A tape is available in a box at each “relais EPI” (first response team meeting point). The team developed a good practice in that area.

The Electrabel headquarter crisis centre in Brussels is provided with communication facilities including videoconference, the copy of the PUI organization and a list containing the contact details of plant suppliers. A pocket-sized prompt action sheet is also issued for all members of that centre.

The maps available in the emergency centers identify the zones within radiuses of 1, 3, 5, 10 and 15 km with predefined monitoring points. The response actions are the responsibility of the authorities in the local, provincial and national levels. For the off-site plan, the priority of the authorities is sheltering together with iodine prophylaxis.

In case of activation of the on-site emergency plan, a specific sound alarm will be activated by the control room. The workers are trained to go to a very well sign-posted gathering point. These gathering points are provided with radiation detectors, badge counting devices, protection equipment, iodine tablets, a communication system and instructions.

The off-site emergency plans are the responsibility of the authorities. The population receives before hand information about radiation effects and stable iodine tablets, distributed through local pharmacies. Other specific target information campaigns have been organized for the farmers in 2006.

The radiological monitoring system in Belgium – TELERAD - is under the responsibility of the Federal Agency for Nuclear Control (FANC). It is a wide monitoring system on Belgian territory, including the surroundings of the French nuclear power plant of Chooz.

A meteorological measuring system is physically installed on the plant on the vent stacks of Tihange 1 & 3.

The plant has two vehicles equipped with air and ground monitoring devices, a computer to process measurements and communication means. Sixty monitoring points within 15 km from the plant are pre-defined for periodic visit. These vehicles are currently in up-grading phase.

A programme for assessing consequences of off-site releases was developed by the Belgium Nuclear Research Center (SCK-CEN). The measurement cell at local and national levels informs the Evaluation Cell of CGCCR to facilitate the decision making process.

The local medical department and off-site medical support are in charge of taking care of the transportation of the irradiated and/or contaminated patient to the hospitals, Centre Hospitalier Huy (CHH) and Centre Universitaire Hospitalier (CHU) in Liège. The latter is equipped with one decontamination room. Doctors and nurses are trained to attend irradiated and/or contaminated injured persons. In case of necessity, Electrabel has arrangements to transfer patients to Percy Hospital in Paris, France.

In case of an emergency, the other Electrabel nuclear power plant in Belgium (Doel NPP) can be called on to provide adequate technical support for Tihange NPP.

A pocket-sized prompt action sheet has been developed and distributed to each emergency team member. It is revised following the PUI revisions. According to each type of event, the immediate response sheets contain the location to which the respective individual has to go, phone, fax and cell phone numbers of contact persons and a summarized description of the roles and responsibilities of that respective individual. This third tool to accelerate response of participants in emergency situation was evaluated by the team as a good practice.

9.3. EMERGENCY PLANS AND ORGANIZATION

The PUI establishes in detail the Electrabel on-site and head office responsibilities, actions, communications, facilities, forms and the interfaces with all authorities involved in a nuclear emergency at the plant.

Although it is required to be revised every five years, the PUI is continuously updated. The PUI is audited by the quality assurance (QA) system. The Authorized Inspection Organization, Association Vinçotte Nucléaire (AVN), has a specific procedure to inspect the PUI. The PUI is organized in the following duties: management, deputy management, environment, chemistry, logistics, mechanical, electrical, nuclear safety and communication.

The training programme for persons on duty is prepared for a year. A detailed plan describes their functions during an emergency. Five notification levels defined by the Royal Decree of 2003 are clearly incorporated into PUI by using technical and radiological criteria. Every form needed for emergency communication is pre-prepared and filled in by emergency staff.

9.4. EMERGENCY PROCEDURES

Emergency operational procedures are available, including beyond design basis accident. Procedures to classify the emergency and to activate the PUI are in a user-friendly form for the operators. Copies of updated emergency procedures are also available in the emergency facilities (Technical Support Centre - COT and Site Emergency Center - COS) for consultation. The procedures are well controlled, reviewed and updated periodically.

9.5. EMERGENCY RESPONSE FACILITIES

The CGCCR is structured in five cells: Decision Making, Measurement, Evaluation, Information and Social-Economic. In case of a nuclear emergency in the plant, two predefined on call members (one from Doel NPP and one from Tihange NPP) are designated to go to the Evaluation cell.

The COS, which is also used for all kinds of emergencies, is very well equipped with redundant communication equipment such as videoconference, hot lines, pagers, fax, mobile phones and conventional telephones, emergency personal protection equipment, iodine tablets, dry food and dosimeters, all in good condition. Emergency procedures and flow diagrams for the 3 units are maintained in the emergency facilities. Software to calculate the expected radiological consequence of release using plant parameters (meteorological data, stack releases) is provided in this centre.

Electrabel has its own telephone system as an important back up for the external Belgacom telephone company.

A complementary information table indicating, in a user-friendly form, the technical and radiological criteria for the five notification levels is also provided for all people concerned at emergency centers (COS, COT, CARA).

The plant has set up a reception and fall-back centre, "Centre d'Accueil et de Repli des Awirs" (CARA), in an Electrabel thermal power plant 12 km from the site. In case of site evacuation, it will be a backup for the COS and a reception point for emergency personnel coming off duty, with decontamination facilities, and a meeting point for those going to the plant. A bus is dedicated to the transportation of the emergency staff. The team developed a good practice in that area.

9.6. EMERGENCY EQUIPMENT AND RESOURCES

Emergency personal equipment and radiological monitoring devices are provided and kept in good condition at the emergency centres, gathering points and first response meeting points. Fire Fighting and medical aid and rescue is available close to the plant.

9.7. TRAINING, DRILLS AND EXERCISES

The plant operators are trained in the emergency procedures on the simulator and in classroom training. An emergency situation training programme exists for Electrabel workers. A wide training programme for contractors has been started and the aim is to conclude it by the end of 2007. Emergency staff also have a very good and wide training programme.

This year, Electrabel started an extensive programme for training external doctors and nurses of the surrounding hospitals to treat irradiated and/or contaminated injured patients.

The fire department is trained in fire fighting on the plant and medical rescue.

The plant performs emergency exercises every year. One of them is the exercise required by the Royal decree. The simulator is used to create the technical scenarios for the exercises close to reality. The plant meteorological measuring system provides real data as information for the scenarios.

In case of actuation of the emergency plan, workers following the sound alarms go to the gathering points, actuate the counting system with their badges and wait for instruction from the leader of that point.

No real evacuation of the site has been tested up to now in these exercises or drills and the plant could miss opportunities to learn how to improve the emergency plan. The team developed a recommendation in that area.

Observers from Electrabel follow exercises and in the exercise debriefing meeting make recommendations to improve the PUI. The plan is subject to a continuous updating process.

Communications exercises are performed inside Electrabel, including at the site, the headquarters and Doel NPP.

9.8. QUALITY ASSURANCE

The emergency plant procedures and the PUI are under the QA programme. Emergency planning and preparedness is in the schedule for QA audits.

9.2. RESPONSE FUNCTIONS

9.2(a) Good Practice: Several means are used by the site to optimize the time in emergency response.

- To ensure rapid access of emergency personnel to the site, when access is limited, specific coloured stickers have been developed and distributed for all vehicles of persons having a role in case of emergency and thus being authorized to enter the site. These coloured stickers also mention the vehicle number plate and are labeled “PUI” (Internal Emergency Plan). The colour of the sticker changes every year. There is an agreement that a specimen of the PUI sticker is sent to the authorities managing traffic in the event of a limited access zone being set up. As well as allowing entrance to the plant, the stickers enables police on roadblocks to identify emergency plan personnel and allow them to pass through. These sticks represents less then 10 % of the distributed stickers.
- If off-site emergency services have to come on site, the meeting points for emergency response teams are defined, signposted on the site and indicated on a plan provided by guards when each emergency service vehicle (fire brigade, ambulances) comes on site. Firstly, a blue flashing light system is activated from the control room to guide the fire department to the affected unit. There are 7 flashing lights on site. In order to ensure that emergency services arrive rapidly at the accident location, a member of the first response team rolls out a tape from the meeting points to actual location of accident. A tape is available in a box at each “relais EPI” (first response meeting point).
- As a result of feedback from EPP exercises, a need for a short document on immediate response management was expressed. Therefore the plant decided to draw up immediate response sheets for each role in the emergency plan on call system. These sheets are in a standardized credit-card sized format and fit easily into a pocket.

  Thanks to these immediate response sheets every role in the emergency plan has all the required information for the immediate actions required in the event of an emergency.

  The front side of the document is generic, while the back is specific to each role. Reference is made to the emergency plan. Accordingly to each type of event immediate response sheets contains following data:

  - Phone, fax and cell phone numbers of contact persons;
  - Summarized description of the roles and responsibilities of that respective individual;
  - Proper reflex sheet, good practices and immediate actions to perform;
  - Sequence in emergency deployment rooms, locations of actors and identification of information flows.

There are similar immediate response sheets for emergency functions at corporate level.

These various improvements optimize time in an emergency response. They ensure that site emergency personnel are able to get on to the plant rapidly and have all the information and instructions for initial actions available in a user-friendly form. They likewise ensure that the off-site emergency services can rapidly reach the location of the accident.

9.5. EMERGENCY RESPONSE FACILITIES

9.5(a) Good practice: Reception of personnel and families at the "Reception and fall-back center" in the event of an accident

The plant has set up an organization for the reception of personnel and families and managing a long accident period, which could last several days. This organization is based in the "reception and fall-back center" in Les Awirs (Centre d'accueil et de repli des Awirs - CARA), which is supplied by power from Awirs power plant.

In the event of an emergency, CARA will fulfill the following functions:

- It can function as an off-site fall-back crisis center in situations where the normal site crisis center (COS) is inaccessible. Contact with the affected unit is maintained using the following means: telephone, fax, computer networks and videoconference.
- It can be used as a point to assemble people. It has a refectory for 100 persons that can also serve as a briefing room for the emergency staff just before they go to the plant. It has a big changing room with 24 showers for decontamination of staff coming off the plant. It also has a conference room with a capacity for 50 members of injured persons' families.
- Personnel can be given personal protective equipment. The teams are transported in a bus which is available 24 hours a day. The drivers have dosimeters and are used to working with the site and know what to do in the event of radioactive contamination.
- There is an infrastructure (meeting rooms, cafeteria, medical room, etc.) for the reception of the families of injured personnel in a calm atmosphere (no pressure from the media, at a distance from the site).

9.7. TRAINING, DRILLS AND EXERCISES

9.7(1) Issue: The plant does not exercise, together with the authorities, in a real format the site evacuation plan for plant staff (plant workers, contractors and visitors) and the plant did not validate the feasibility of this phase of the emergency plan.

The team found following facts:

- During Emergency plan drills and exercises, site evacuation has not been tested in real conditions to evaluate the capability of workers evacuation, the mobilization of the transportation means and the behaviors of the drivers.
- On the parking lot vehicles are not parked in a way to facilitate the fast exit from the site without any risk of car accidents. Real exercises or drills could test the efficiency of the lay out of the parking lot.
- Some workers, visitors and contractors may come to the plant without using their private cars. So it is possible that group transportation needs to be organized to evacuate such kind of person.
- No test alternative evacuation routes were tested to evacuate from the site.

Without arranging an exercise in a real format for the site evacuation, the plant could not validate the feasibility of this phase of the emergency plan, thus missing the feedback that could help in improving this plan.

Recommendation: The plant should arrange, preferably with the authorities, an exercise in a real format for site evacuation (plant workers, contractors and visitors) to validate the feasibility of this phase of the emergency plan.

IAEA Basis: GS-R-2; 5.33: Exercise programmes shall be conducted to ensure that all specified functions required to be performed for emergency response and all organizational interfaces for facilities in threat category I, I or III and the national level programmes for threat category IV or V are tested at suitable intervals.

DEFINITIONS

DEFINITIONS - OSART MISSION

Recommendation

A recommendation is advice on how improvements in operational safety can be made in the 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 fulfillment of current requirements or expectations. It should be superior enough and have broad application to be brought to the attention of other nuclear power plants and be worthy of their consideration in the general drive for excellence. A good practice has the following characteristics:

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

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

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

LIST OF ABBREVIATIONS

AAR	After action review
AIO	Authorized Inspection Organization
ALARA	As Low As Reasonably Achievable
AVN	Non-profit organization Association Vinçotte Nuclear
BO	Business oversight meeting
BUG	Business Unit Generation
CA	Corrective action
CARA	Centre d'accueil et de repli des Awirs
CARE	Nuclear safety, health and safety, radiation protection and environment
CED	Collective effective dose
CGCCR	National crisis center
CHH	Hospital center of the town Huy
CHU	University hospital center
CMOD	Modification committee
COS	Site emergency center
COT	Technical support center
CRO	Main control room operator
CTC	Competence and Training Center
DCM	Daily coordination meeting
DG	Diesel generator
DML	light modification
DMS	Document management system
EBL	Electrabel Company
ECM	Exploitation coordinator manager
ECNSD	Electrabel Corporate Nuclear Safety Department
ECOS	Emergency call-out system
EDF	Electricité de France
EMAS	European Eco Management Audit Scheme
EP	Essai périodique – periodic test
EPI	Internal emergency fire fighting and rescue team
EPRI	Electric Power Research Institute
FANC	Federal Agency for Nuclear Control
FE	Experience form
FIN	Fix-it-now team
FME	Foreign material exclusion
FO	Field operator
FROG	Framatom owners group
FSAR	Final safety analysis report
GET	General employee training
GMS	Generation management system
HP SIS	High pressure safety injection system
HR	Human Resources
ICRP	International commission on radiological protection
ICRU	International commission on radiation units and measures
INES	International nuclear event scale
INSC	Independent nuclear safety committee
ISI	In-service-inspection
ISO	International Organization for standardisation

JIT	Just-in-time
KPI	Key performance indicator
LOCA	Loss of coolant accident
MNI	Non-important modification
MoM	Minute of the meeting
MS&I	Maintenance, surveillance and in-service-inspection
MSDS	Material safety data sheet
NIS	Nuclear in service
NMNI	Non non-important modification
NPP	Nuclear power plant
NWP	National warning point
ODM	Operational decision making
OE	Operating experience
OJT	On-the-job training
OP	Operation sections
OPEX	Operating experience programme
OPS	Operations
PAT	Public address terminal
PDCA	Plan-Do-Check-Act process
PJB	Pre-Job-Briefing
PORC	Plant (unit) operation review committee
PPE	Personnel protective equipment
PPM	Process and performance programme
PSA	Probabilistic safety analysis
PUI	"Plan d'urgence interne" – Internal emergency plan
PWOG	Pressured water owner group
QA	Quality assurance
QC	Quality control
RCA	Radiation controlled area
RCM	Reliability centered maintenance
RP	Radiation protection
RPV	Reactor pressure vessel
RVH	Reactor vessel head
SAP	System applications and products
SAR	Safety analyse report
SAT	Systematic approach to training
SCK-CEN	Belgium nuclear research center
SFP	Spent fuel pool
SG	Steam generator
SORC	Site operation review committee
SPDS	Safety parameter display system
SRW	Solid radioactive waste
SS	Shift supervisor
SSC	Structure, system and components
TC	Technical consultant
TCI	Plant process computer application
TPI	Training performance indicator
TS	Technical specifications
VOA	Task observation programme
WCA	Work clearance acceptation

LIST OF IAEA REFERENCES (BASIS)

Safety Standards

SF-1; Fundamental Safety Principles (Safety Fundamentals)

Safety Series No.115; International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources

Safety Series No.117; Operation of Spent Fuel Storage Facilities

NS-R-1; Safety of Nuclear Power Plants: Design Requirements

NS-R-2; Safety of Nuclear Power Plants: Operation (Safety Requirements)

NS-G-1.1; Software for Computer Based Systems Important to Safety in Nuclear Power Plants (Safety Guide)

NS-G-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)

GS-R-1; Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety (Safety Requirements)

GS-R-2; Preparedness and Response for a Nuclear or Radiological Emergency (Safety Requirements)

GS-R-3; The Management System for Facilities and Activities (Safety Requirements)

GS-G-2.1; Arrangement for Preparedness for a Nuclear or Radiological Emergency (Safety Guide)

GS-G-3.1; Application of the Management System for Facilities and Activities (Safety Guide)

50-C/SG-Q; Quality Assurance for Safety in Nuclear Power Plants and other Nuclear Installations (Code and Safety Guides Q1-Q14)

RS-G-1.1; Occupational Radiation Protection (Safety Guide)

RS-G-1.2; Assessment of Occupational Exposure Due to Intakes of Radionuclides (Safety Guide)

RS-G-1.3; Assessment of Occupational Exposure Due to External Sources of Radiation (Safety Guide)

RS-G-1.8; Environmental and Source Monitoring for Purpose of Radiation Protection (Safety Guide)

WS-G-6.1; Storage of Radioactive Waste (Safety Guide)

DS347; Conduct of Operations at Nuclear Power Plants (Draft Safety Guide)

DS388; Chemistry Control in the Operation of Nuclear Power Plants (Draft Safety Guide)

INSAG, Safety Report Series

I**NSAG-4**; Safety Culture

INSAG-10; Defense 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

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

TECDOCs and IAEA Services Series

IAEA Safety Glossary Terminology used in nuclear safety and radiation protection 2007 Edition

Services series No.10; PROSPER Guidelines

Services series No.12; OSART Guidelines

TECDOC-489; Safety Aspects of Water Chemistry in Light Water Reactors

TECDOC-744; OSART Guidelines 1994 Edition (Refer only chapter 10-15 for Pre-OSART, if applicable.)

TECDOC-1141; Operational Safety Performance Indicators for Nuclear Power Plants

TECDOC-1321; Self-assessment of safety culture in nuclear installations

TECDOC-1329; Safety culture in nuclear installations - Guidance for use in the enhancement of safety culture

TECDOC 1446 OSART mission highlights 2001-2003

TECDOC-1458; Effective corrective actions to enhance operational safety of nuclear installations

TECDOC-1477; Trending of low level events and near misses to enhance safety performance in nuclear power plants

TECDOC-955; Generic Assessment Procedures for Determining Protective Actions during a Reactor Accident

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

ACKNOWLEDGEMENT

The Government of Belgium and the staff of Tihange Nuclear Power Plant provided valuable support to the OSART mission to Tihange NPP. Throughout the whole OSART mission, the team members felt welcome and enjoyed excellent cooperation and fruitful discussions with Tihange Nuclear Power Plant managers and staff, and other local and national authorities. Information was provided openly and in the spirit of seeking improvements in operational safety. There was a rich exchange of knowledge and experience which contributed significantly to the success of the mission. It also established many personal contacts that will not end with the completion of the mission and submission of this report. The efforts of the plant counterparts, liaison officers, interpreters and the secretaries were outstanding. This was of significant support to the OSART team in order to complete its mission in a fruitful manner.

The IAEA, the Division of Nuclear Installation Safety and its Operational Safety Section wish to thank all those involved for the excellent working conditions during the Tihange Nuclear Power Plant review.

TEAM COMPOSITION OSART MISSION

DUBOIS, Dominique – IAEA
Division of Nuclear Installation Safety
Years of Nuclear Experience: 29
Team Leader

SENGOKU, Katsuhisa – IAEA
Division of Nuclear Installation Safety
Years of Nuclear Experience: 17
Deputy Team Leader

BASSING, Gerd – Germany
EnBW Kraftwerke AG , , Kernkraftwerk Phillipsburg
Years of Nuclear Experience: 32
Review area: Management, organization and administration

MO, Yinliang – China
Third Qinshan Nuclear Power Co., Ltd.
Years of Nuclear Experience: 17
Review area: Training and qualifications

MARTYNENKO, Yuri - Russia
All-Russian Research Institute for Nuclear Power Plant Operations
Years of Nuclear Experience: 23
Review area: Operations I

QUEGUINER, Alain – France
Electricité de France (EDF) – CHINON Nuclear Power Plant
Years of Nuclear Experience: 25
Review area: Operations II

MONGRAIN, Robert L. - Canada
Ontario Power Generation, Pickering Nuclear Power Plant
Years of Nuclear Experience: 29
Review area: Maintenance

GENOV, Stoyan Hristov – Bulgaria
Kozloduy Nuclear Power Plant
Years of Nuclear Experience: 24
Review area: Technical support

FOTEDAR, Suresh Kumar - IAEA
Division of Nuclear Installation Safety
Years of Nuclear Experience: 32
Review area: Operating experience feedback

ZRUBEC, Milan - Slovakia
Mochovce Nuclear Power Plant
Years of Nuclear Experience: 22
Review area: Radiation protection

ZOTICA, Dorina – Romania
Societatea Nationala “Nuclearelectrica” - S.A, “CNE-PROD” Cernavoda
Years of Nuclear Experience: 23
Review area: Chemistry

WERNECK DE CARVALHO, Paulo - Brazil
Central Nuclear de Angra-1
Years of Nuclear Experience: 30
Review area: Emergency planning and preparedness

ERMOLAEV, Alexander –Russia
Balakovo Nuclear Power Plant “Rosenegoatom”
Years of Nuclear Experience: 21
Observer

SANDER, Ulrich – Germany
EnBW Kernkraft GmbH, Kernkraftwerk Neckarwestheim
Years of Nuclear Experience: 14
Observer

KERHOAS, Anne - IAEA
Division of Nuclear Installation Safety
Years of Nuclear Experience: 6
Observer