



**REPORT  
of the  
OPERATIONAL SAFETY REVIEW TEAM  
(OSART)  
MISSION  
to  
BRUNSWICK Nuclear Plant  
United States of America**

**9-25 May 2005**

**DIVISION OF NUCLEAR INSTALLATION SAFETY  
OPERATIONAL SAFETY REVIEW MISSION  
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## **PREAMBLE**

**This report presents the results of the IAEA Operational Safety Review Team (OSART) review of the Brunswick Nuclear Plant, United States of America. It includes recommendations for improvements affecting operational safety for consideration by the responsible United States of America organizations and identifies good practices for consideration by other nuclear power plants.**

**Any use of or reference to this report that may be made by the competent Government of the United States of America organizations is solely their responsibility.**

**FOREWORD**  
**by the**  
**Director General**

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

An OSART mission, carried out only at the request of the relevant Member State, is directed towards a review of items essential to operational safety. The mission can be tailored to the particular needs of a plant. A full scope review would cover nine operational areas: management, organization and administration; training and qualification; operations; maintenance; technical support; operating experience; 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 Nuclear Safety Standards (NUSS) programme and the Basic Safety Standards for Radiation Protection, and the expertise of the OSART team members form the bases for the evaluation. The OSART methods involve not only the examination of documents and the interviewing of staff but also reviewing the quality of performance. It is recognized that different approaches are available to an operating organization for achieving its safety objectives. Proposals for further enhancement of operational safety may reflect good practices observed at other nuclear power plants.

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

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

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

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## INTRODUCTION AND MAIN CONCLUSIONS

### INTRODUCTION

At the invitation of the Government of the United States of America, a three-week Operational Safety Review Team (OSART) mission was conducted at Brunswick Nuclear Plant (BNP) in the USA, from 9 to 25 May 2005. The plant is located in North Carolina on the bank of the Cape Fear River near Southport on the coast of the Atlantic Ocean. The site contains two BWR units, with a rated output of 960 MWe each. Unit 2 commenced its commercial operation in 1975 and Unit 1 in 1977. Brunswick Nuclear Plant is part of Progress Energy which is one of the top ten generators of electricity in the United States with 24,000 MW of generation capacity.

The Brunswick OSART mission was the 132<sup>nd</sup> in the programme, which began in 1982. The team was composed of experts from Canada, Slovakia, the United Kingdom, Russia, Japan, France, the Czech Republic, Germany, and Hungary together with three IAEA staff members. In addition, an observer from the Institute of Nuclear Power Operations (INPO) was part of the team. The collective nuclear power experience of the team was approximately 300 person-years.

The team traveled to Southport on Friday, 6 May 2005. Saturday and Sunday (7-8 May) were spent on team training activities. Following the entrance meeting, which took place on Monday, 9 May, the team commenced the OSART review. A report was completed by the team and a summary of this report was presented at an exit meeting on Wednesday, 25 May.

In addition to senior managers and staff from Brunswick Nuclear Plant and Progress Energy, representatives from the US Nuclear Regulatory Commission (US NRC) attended the exit meeting. The team leader presented the team's report at a meeting with senior management of US NRC Region 2 on Thursday, 26 May in Atlanta.

The purpose of the mission was to review operating practices in the areas of management, organization and administration, training and qualification, operations, maintenance, technical support, operating experience, radiation protection, chemistry and emergency planning. In addition, a comprehensive exchange of technical experience and knowledge took place between the experts and their plant counterparts on improvements in operational safety that could be further pursued.

Prior to actually visiting the plant, the team studied information provided by the IAEA and the Brunswick Nuclear Plant to familiarise themselves with the plant's main features and operating performance, staff organization and responsibilities, important programmes and procedures and IAEA Safety Standards relevant to the mission. During the mission, the team reviewed many of the plants programmes and procedures in depth, examined the plants performance, observed work in progress, and held in-depth discussions with plant personnel, NRC staff and off-site authorities.

Throughout the review, the exchange of information between the OSART team members and plant personnel was very open, professional and productive. In addition the experts were able to observe plant actions during an operational event i.e. "Loss of emergency bus E 1". The plant personnel response was observed to be very professional and comprehensive.

The emphasis of the review was directed at assessing the operational safety performance and effectiveness of management rather than simply the content of programmes. The conclusions of the OSART team were based on the plants performance compared with the IAEA Safety Standards and good international practices.

## **MAIN CONCLUSIONS**

The OSART team concluded that there is efficient horizontal and vertical communication among the managers and staff. The team found good areas of performance which included the following:

- A strong self-assessment programme and tools
- The comprehensive use of operating experience
- A comprehensive safety and performance indicator programme
- An excellent training programme and training facilities
- A strong cohesive management team

The OSART team offered proposals for further improvements in operational safety. The most significant proposals include the following:

- Reinforcement of the implementation of management expectations in the field
- Attention to certain operational issues
- Improvement of aging management/material condition of some systems, structures, and components of the plant
- Measures to prevent the potential spread of contamination

Brunswick Nuclear Plant 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.

An important element of the OSART review is the identification of those findings that exhibit positive and negative attributes of safety culture. The OSART team used the guidance provided in INSAG-4, INSAG-13, INSAG-15, IAEA Safety Reports Series No.11, IAEA-TECDOC-1321 and 1329 to assess various aspects of safety culture at the Brunswick NPP.

The safety culture review was integrated on a daily basis into the OSART review process. The results of the safety culture review were based on team members daily observations and interviews with the Brunswick NPP staff, a review of the material condition and housekeeping of the plant and an evaluation of the programmes, processes and procedures used at the plant.

The results of the safety culture review are included in the chapter entitled management, organization and administration.

## 1. MANAGEMENT, ORGANIZATION AND ADMINISTRATION

### 1.1. CORPORATE ORGANIZATION AND MANAGEMENT

The Brunswick Nuclear Plant (BNP) is a two unit boiling water reactor site with both units recently up-rated to approximately 960 MWe. The BNP Unit 2 was placed in service in 1975 and BNP Unit 1 in 1977. BNP is operated by Progress Energy, which was formed in 2000 through the merger of Carolina Light & Power and Florida Progress.

Progress Energy operates five reactors at four sites in the Carolinas and Florida. The responsibility for operation of the Nuclear Generation Group (NGG) rests with the Senior Vice President (SVP) Nuclear Generation/Chief Nuclear Officer (CNO).

The NGG is focused on leveraging the opportunities of multi-site performance and works to conduct its business as a single fleet. The NGG utilizes a common management approach and strives to have all plants share the same vision, mission and common set of values and strategies. The NGG values and strategies are rolled out utilizing a set of NGG Directives approved by the CNO and a common NGG business plan identifies the critical success factors and strategic initiatives to accomplish the vision. Also, NGG utilizes common procedures, processes and Key Performance Indicators (KPI) owned by various functional peer groups and directed by the senior management peer group in an effort to establish standardized processes and promote continuous improvement.

The CNO receives monthly updates on plant performance through a report generated by the Performance Evaluation Section (PES). The report is comprehensive and covers a wide cross section of plant operation including an update on the status of performance indicators, status of plant organizational performance issues, and identifies or updates status on any significant issues. The CNO regularly attends Nuclear Safety Review Committee meetings.

Progress Energy has offered a "Voluntary Enhanced Retirement Program" (VERP) to all employees in the corporation as part of cost reduction initiatives. Staff meeting minimum age (50 years) requirements have been given the option of retiring early. The programme is being implemented equally across the corporation, including the NGG. Recognizing the potential impact of reducing staffing levels at the NGG plants, the CNO initiated a review at all plants to determine the "cap" or limit in organizations or critical areas, below which, safe and efficient operation of the plant could be challenged. Those staff in NGG that have accepted the package have recently been announced.

### 1.2. PLANT ORGANIZATION AND MANAGEMENT

A single plant organization exists at BNP for both units and is headed by the site Vice President (VP). Reporting to the SVP/CNO, this position is responsible for managing design basis configuration control, services associated with procurement, design and modification installation, outage management, direct plant support functions, operation and maintenance. Reporting to the VP are the Director of Site Operations (DSO), Site Services Manager and Nuclear Assessment Manager.

The DSO position was created largely as a developmental position between the Plant General Manager (PGM) and VP positions. It is intended to increase depth at this senior level in the organization and facilitates increased focus on key elements of the plant infrastructure. The DSO is responsible for plant operations, training, engineering support and scheduling/coordination and is supported by managers in each area. The focus of the DSO



position is to exercise the direction necessary to ensure safety of the public, plant personnel and plant equipment as well as maintaining high availability of plant generating capacity.

The PGM is responsible for all phases of plant operation and maintenance. This includes adherence to all requirements of the Operating License, Technical Specifications and Quality Assurance Program. He is supported in these responsibilities by the operations manager, maintenance manager and environmental and radiation control manager.

The plant demonstrates a strong commitment to establishing and maintaining leadership and strength at the management level. A key driver in this area is a well developed Management Succession Planning & Development Programme. Key elements of the programme are individual talent assessments and development plans, establishment of depth in the organization, work force assessment and a senior management strategic assessment.

Functions, responsibilities and authority for management and superintendent positions are defined in the updated Final Safety Analysis Report (FSAR) and are typically re-stated in department conduct of operations documentation. Functions and responsibilities for supervisors and staff in the line organization are not fully defined in plant documentation. The plant documents and communicates this information through the performance evaluation programme.

The plant currently operates with approximately 715 permanent employees and 56 long-term or core contract staff. Fifty-four of the contract staff are in the maintenance department. Overtime averages are not excessive and current staffing levels are deemed adequate by the team. Results of the VERP specific to the plant are that 61 employees have accepted the package. Plant management informed the team that their intention was to maintain permanent staff levels near current values and refill the majority of the VERP positions. Each position that had to be filled was assessed and release dates were determined based on projections of when qualified replacements could be made available. The latest release dates are December of 2005.

Perhaps the most significant challenge presented by the VERP is the knowledge and experience that will be leaving with these senior staff. This is recognized by the plant and their knowledge retention programme has been accelerated. Key elements of the accelerated programme include benchmarking other utilities already addressing the issue of knowledge and skill retention, risk assessment and prioritized ranking and hiring plans for critical skills to allow for turnover. Plant management report they do not anticipate any measurable reduction in performance during this transition period.

A comprehensive fitness for duty policy and procedure exist. The plant has a fitness for duty supervisor and 3 permanent staff reporting through the security organization. Random checks are performed for alcohol, illegal substances and misuse of legal substances. This group is also responsible for coordinating security clearances.

The Nuclear Regulatory Commission (NRC) is represented onsite by two resident inspectors. In addition to having access to all the technical information of the plant, they have the opportunity to attend any meetings and were observed doing so throughout the review period. Plant management and the NRC resident inspectors consider the everyday relations as satisfactory. Daily communication allows both organizations to anticipate future problem areas affecting safety.

### 1.3. MANAGEMENT ACTIVITIES

The NGG and BNP business plans and NGG directive on Conduct of Fleet Operations clearly define policies, goals and objectives and the Conduct of Fleet Operations document details specific CNO directed values and strategies. An integrated performance based management approach is in place and a strong focus is demonstrated on assessing and improving safety performance. Participation at all levels in the organization is evident.

Key performance indicators are employed to monitor performance against expectations, actual performance is measured and current progress and status is displayed throughout the plant.

The plant has a solid human performance programme in place with a human performance steering committee providing oversight. Each major organization develops and maintains specific action plans to address unique human performance challenges.

Supplementing the human performance programme is a very good "Employee Concerns Program" (ECP) established as a NGG initiative to promote a safety conscious work environment in the plants. The mission of the ECP is to provide a two-way communications channel between employees and senior management, enabling employees (including contractors) to raise any concern/allegation, pose a question, or express an opinion on any nuclear safety concern or any company related topic. Concerns can be input directly to the site ECP representative or anonymously using ECP concern boxes located throughout the plant. Significant effort is made to protect the anonymity and confidentiality of the submitter and timely feedback is provided to all concerns.

Considerable effort has been undertaken by the plant to ensure all personnel are informed and current on critical plant and company activities. Very good horizontal and vertical communication mechanisms are employed through scheduled daily meetings at all levels and within the departments and the team considers this a good practice.

Management efforts have been effective in fostering a culture that promotes good teamwork, focuses the staff on the operational needs of the station, and fosters a healthy work environment. All levels of the organization have a low tolerance for behaviors that do not support team efforts. The team considers this a good practice as well.

Despite these comprehensive programmes and initiatives, the team notes that management expectations are not being met in some areas and has made a recommendation in this area.

### 1.4. MANAGEMENT OF SAFETY

The safety policy for the plant is defined in the business plan and high standards for safe and efficient operation of the plant are established. Operational excellence in the area of safety is identified as a critical success factor. The importance of safety is widely and effectively communicated through the plant. The safety message is conveyed at every level of the company and every meeting begins with a safety topic and operating experience. Systematic pre-job briefings always begin with industrial safety comments. In the case of particular events, the daily meetings, from the workshop floor to the corporate level begin with the same safety information.

Planning and scheduling of all work is performed with an emphasis on risk assessment. A blended approach of quantitative and qualitative risk assessment is performed for on line

work, taking into account all activities in the plant. Probabilistic risk profiles are established and updated and staff is continuously aware of current risk conditions.

The team noted a positive environment at the plant where the learning function of the organization is promoted. Identification of problem areas or potential problem areas is encouraged and sought after at all levels of the organization and critical assessments are generally welcomed. A key driver in this learning initiative is the self assessment programme and the team considers this a good practice.

The team noted that safety performance is not identified as being part of the succession planning and development programme and has made a recommendation in the area of management of safety.

The most significant positive safety culture attributes observed by the team with the management and staff of the plant are:

- Mission and vision of the Corporate Business Plan and Brunswick plant policies clearly establishing safety as the first priority
- Benchmarking activities
- Questioning attitude of all personnel. Management reinforcement of this questioning attitude
- Good management team working together to implement programmes and activities
- Strong self-assessment fostering a self-evaluation culture.
- Efficient communications (horizontal, vertical and cross sectional). Staff eager to answer questions and cooperate
- Discipline of the personnel, attentive to adhering to established procedures

The team also identified several areas where management and staff of the plant are encouraged to continue to enhance safety culture. These include:

- Efforts to further improve the plant installations
- Increase attention for continuous improvement to reach excellence well above the compliance of requirements
- Self criticism when observing safety systems and components, striving to implement effective changes in the long term justification versus engineering analysis as a way to solve issues
- Further expanding the external operating experience activities by including the search for international practices worldwide that may be useful to further improve the plant installations and practices

The team concluded that there is a high commitment to nuclear safety clearly stated in the mission and vision for the management of Brunswick NP. The plant team that contributed to the good preparation for the OSART mission and all the plant staff that contributed to their implementation is encouraged to continue with their efforts for sustaining the momentum to make continuous improvement. Senior managers are also encouraged to continue with their initiative to develop a safety culture environment in accordance with developments promoted by the IAEA and other world organizations. The implementation of the OSART recommendations and suggestions will contribute to management's support to improve the safe operation of the plant.

## 1.5. QUALITY ASSURANCE PROGRAMME

A well defined nuclear oversight process is in place to promote and ensure safe and efficient operation of the plant. Two groups, the Plant Nuclear Safety Committee (PNSC) and the Nuclear Assessment Section (NAS), provide internal oversight and the Nuclear Safety Review Committee (NSRC) provides external oversight.

The Nuclear Assessment Section (NAS) is responsible for implementation of the Quality Assurance (QA) programme. Functional responsibilities are split between a Plant Operations Assessment unit and a Quality Control (QC) unit reporting to the NAS Manager. The functions and responsibilities of the NAS and the individual units are clearly defined as well as interactions between the NAS and other NGG organizations.

Minimum audit requirements are set out and managed through use of a commitment database. Compliance and reporting is documented to the site VP and the corporate office. Performance based assessments are also performed as well as focused looks initiated by the site VP or other senior management staff. Assessment procedures are clearly written and comprehensive. Assessment results are broken down into best practice, issues, weaknesses and items for management consideration categories. Findings are backed by documented facts and observations and significant areas of improvement from previous assessments are also documented. The QA programme is enhanced through implementation of an assessor rotation programme and the team considers this a good practice.

The Quality Control (QC) unit performs the traditional QC surveillance functions and also performs all Non Destructive Examination (NDE) for the plant. A peer inspection programme has been established where maintenance personnel are qualified to QC technician standards and perform QC on pre-defined activities. The programme works to drive quality to the line organization and improve work efficiency by allowing craft to perform their QC inspections where appropriate. Peer inspectors are independent in that they do not perform or directly supervise the work being inspected.

The QA function at BNP is further enhanced through support from the corporate Performance Evaluation Support (PES) group. This group provides independent assessment of the NAS programme and the QA programmes of the NGG fleet. Functions and responsibilities of this group are also clearly defined and a member is permanently stationed at the BNP site. A comprehensive, plant wide, corporate assessment is performed every two years.

## 1.6. INDUSTRIAL SAFETY PROGRAMME

The industrial safety programme is largely implemented through the Plant Safety Advisory Committee and functional area Safety Councils. There are approximately ten safety councils for the functional groups, each meet monthly focusing on a safety topic defined by the corporate safety organization. Each council has a chairman and secretary and staff within the department is rotated through these positions on an annual basis. The employee filling the secretary position typically fills the chairman position the succeeding year. The rotation of staff through the secretary and chairman positions is considered an element of the leadership training initiative.

A safety representative reporting to the corporate office is assigned to the plant to oversee implementation of the industrial safety programme. In addition to plant responsibilities, the safety coordinator supports other plants in NGG during outages. A number of observations were made by the team indicating increased surveillance of industrial safety issues in the

plant could improve performance in this area. Three scaffolds were found in place with the posted removal date exceeded, an electrical safety hook missing in a diesel generator electrical room and a ladder missing at a fire ladder station. The safety representative reported that he targeted once per week to perform tours focused on industrial safety.

#### **1.7. DOCUMENTS AND RECORDS MANAGEMENT**

The document management system is implemented almost entirely using an electronic document and records management tool widely used in the industry. The entire life cycle of a document is managed using this tool including preparation, tracking, revision, electronic review and approval. Documents are available at all desk tops in the plant and appropriate procedures and training is in place to ensure only most current revisions are used.

The system also facilitates initiating, prioritizing and tracking of Procedure Revision Requests (PRR). A PRR is prioritized by the document sponsor as Priority 1 (P1) – when the affected procedure cannot be used as is for personnel safety or equipment damage reasons or possible violation of regulations or Technical specifications, Priority 2 (P2) – when the affected procedure can be safely used but could result in a commitment violation, conflict in procedures or adverse condition and Priority 3 (P3) – when the affected procedure change will improve efficiency, improve human performance or add clarity. There were no open P1 PRRs at the time of the review.

Records management is implemented through an in house electronic records management system and also made available to all staff at their desk top. All documents and records assigned for retention are converted to microfilm with QC on duplication quality and filed in a well maintained, spacious facility. The facility meets all access control, temperature and humidity control and fire protection standards and all stored objects were well indexed, filed and accessible.

## DETAILED MANAGEMENT, ORGANIZATION AND ADMINISTRATION FINDINGS

### 1.3. MANAGEMENT ACTIVITIES

**1.3(1) Issue:** Although comprehensive management programmes have been established at the plant, there remains a gap between some declared expectations of managers and results observed in the field.

- Deficiencies of certain systems, structures, and components are evident at the plant due to aging and saltwater conditions.
- Improvement can be made in engineering for the identification and resolution of plant issues.
- The hydrogen water chemistry system performance and reliability are not meeting plant standards.
- Some radiation controls practices may not provide sufficient protection against the spread of radioactive contamination.
- The guidance to the licensed operators regarding the procedures which should accompany the operators if the control room has to be vacated and subsequent plant shutdown is required to be conducted from the shutdown panel has some ambiguity.

Without enforcement and implementation of management expectations, opportunities to correct problems related to safety could be missed.

**Recommendation:** The plant should accelerate/reinforce implementation of declared managerial expectations.

**Basis:** IAEA Safety Standard NS-G-2.4-3.6 and 5.7

**1.3(a) Good practice:** The Brunswick NP team utilizes multiple communication actions to ensure all personnel are informed and current on critical plant and company activities. These include general communications efforts to provide "big picture" information to employees and specific up to the minute technical information.

Information is communicated through:

- Daily (Monday – Friday) e-mail of "Brunswick News"
- Periodic e-mail management updates via "Straight Talk"
- Daily Outage Newsletter
- Daily (Monday – Friday) OSART Newsletter
- Monthly site management meetings attended by all supervisors and managers
- Twice weekly site leadership meetings (Monday and Thursday @ 0800)
- Daily (Monday – Friday) Plan of the Day meetings @ 0730
- Weekly Site Vice President Lunch meeting with employees
- Quarterly Senior Management Compliments and Concerns meetings

- Weekly cycle training management luncheons
- Bi-Annual "all-hands" employee meetings attended by all available people at the site

Current technical information is provided to a wide circle of plant staff through various computer systems. Plant personnel have easy direct access to this information. A few examples of this type of information are:

- Daily operator and turnover logs from the operating shift
- The work control system is on-line and workers can view the files on a read only basis. This allows people quick access to the latest on-line maintenance schedules and resource profile maps for system outages, as well as information on equipment out of service, scheduled system runs as well as system outage windows. It also includes restrictions placed on equipment such as limits on modifications or HVAC work. These profiles are updated automatically as adjustments are made.
- Site drawings, training records, licensing documents and other quality assurance documents are readily available over the computer.
- The BNP emergency preparedness (EP) internal web-site presents information in a format that is easy to read. It is current in a timely manner by the EP Staff and it contains links to these EP related documents that can be easily accessed by all employees for review:

As a result of the extensive communications outreach, employees are well informed on relevant issues, knowledgeable about important technical aspects of their jobs and quickly alerted when they need to respond. This results in increased ownership and pride in work performed well.

### **1.3(b) Good practice: Site Teamwork**

Management efforts have been effective in fostering a culture that promotes good teamwork, focuses the staff on the operational needs of the station, and fosters a healthy work environment. All levels of the organization have a low tolerance for behaviors that do not support team efforts.

A group of about 40 managers, superintendents, and supervisors participates in biannual team building exercises. Significant management time and company resources are invested to help build teamwork and enhance relations with the local community.

An operational focus list is used to track and resolve current issues that challenge operational needs of the station. Each item on the list has an assigned owner of accountability and an associated action plan. A large number of senior reactor operators throughout the organization facilitate the use of this tool.

Multi-organizational teams are utilized to perform project level work such as the development of a refuel team, comprised of mechanics, operators, I&C technicians, HP's and engineering. This concept is used in other multi-organizational teams. High Impact Teams (HIT) are utilized for the development of complicated and critical projects to be performed during a refuel outage. These HIT teams are comprised of

O&S, maintenance, operations, engineering and HP personnel to ensure that all competencies are represented.

#### 1.4. MANAGEMENT OF SAFETY

- 1.4(1) Issue:** Although a commitment to safety is evident at the plant, the Management Succession Planning & Development Programme does not include safety performance in both the talent assessment and ranking process, or as a specified core skill.

Failure to develop and maintain strong management leadership in safety management activities can lead to a weakening safety culture and degradation of safety performance.

**Recommendation:** Plant management should review the Management Succession Planning & Development Programme and ensure that safety performance is included in the assessment and ranking process and developed as a core skill.

**Basis:** IAEA Safety Standard NS-R-2-2.8.

- 1.4(a) Good practice:** The plant has developed a comprehensive and intrusive self-assessment programme within the organization that has led to improvements in the quality of work across all plant disciplines.

In 2005, Brunswick NP is scheduled to conduct 39 formalized team self-assessments spanning all functional areas. In 2004, the station conducted 41 self-assessments. All self-assessments are required to have a structured outline approved in advance of the assessment activity. Additionally, self-assessments are required to be led by a qualified self-assessment team leader. Team membership is diverse and frequently includes external peers from other nuclear facilities. All of the aforementioned is planned and submitted for management review and approval prior to commencing assessment activities.

The self-assessment team focuses on targeted performance against pre-determined management requirements as well as industry best practices. Deficiencies are categorized as issues, weaknesses, or items for management consideration and documented in the station's corrective action programme. 2004 self assessment activity identified greater than 100 items which were subsequently categorized in the corrective action program and resolved according with the plant schedule.

The programme promotes self critical behaviors and encourages the identification of deficiencies by the organization itself, versus identification by the Quality Assurance organization or the regulator.

#### 1.5. QUALITY ASSURANCE PROGRAMME

- 1.5(a) Good practice:** The Nuclear Assessment Section (NAS) Personnel Rotation Programme fosters a strong self-evaluation culture in the line organization while continually providing sound technical expertise for the assessment organization. The assessor rotation programme selects top performers for two to three year rotational assignments as independent assessors in the NAS. The selected individuals qualify as assessors and lead assessment teams in their functional areas and participate as team



members for NGG assessments within and beyond their area of expertise. Plant performance and line organizations benefit in the following ways:

- The assessors have up to date line organization experience and know the critical areas affecting performance.
- The assessors return to their line organizations, typically in leadership roles, with strong self-evaluation perspectives.
- The assessors develop a good understanding of the basis for the nuclear quality assurance requirements providing them with a valuable perspective for overseeing the line organization's self-evaluation activities.
- The rotational assignment fosters an improved acceptance of critical feed back upon return to the line organization.
- The benefits to the NAS organization from the rotational programme are:
- High performing selected individuals are typically selected for assessment rotations. This adds credibility to the assessment findings and follow-up on corrective actions.
- A continuing source of technical expertise familiar with current line organization programmes, functions and processes.
- Frequent new perspectives and questioning attitudes strengthen the assessment processes.

This staffing approach strengthens both the line and assessment organizations while providing unique professional development opportunities for the individuals.

## 2. TRAINING AND QUALIFICATIONS

### 2.1. ORGANIZATION AND FUNCTIONS

Human resources represent a key role in overall company and plant strategies and training is recognized as essential to having an appropriate number of highly qualified personnel. This is explicitly expressed in the business plan.

Training section positions in the organizational chart adequately support the training while it is assured that the ownership of the training is with the respective section/department. Responsibilities of managers, supervisors, training personnel and employees are well established in plant operating manual (POM) – "Brunswick Training Programme". To support the adequacy and appropriateness of the training, the "Training Advisory Board and Training Programme Committees" are established. They ensure full compliance with corporate and plant policy for highly qualified and competent personnel, to assure top performance in safety and production.

The job positions where accredited training programmes are required are non-licensed operator (NLO), reactor operator/control operator (RO), senior reactor operator (SRO), shift manager of operations, shift technical advisor, radiation control technician, instrument and control/electrical maintenance technician, mechanical maintenance technician, maintenance supervisor, engineering support personnel, and chemistry technician.

Minimal required education and experience requirements for these job positions are established in respective INPO documents and company requirements are established in respective company procedure.

"Full Systematic Approach to Training" (SAT) is used for training where the accreditation is required. Procedures for individual SAT phases are established and kept updated. Learning objectives are used, training materials and training aids are adequately developed for both the instructor and trainees. The training section tracking system is established for tracking of training modifications and changes. Evaluation of the training is done in full compliance with the international practices and the following sources of data are used for training evaluation: student feedback, line & training management observation, instructor evaluations, site observations, student performance evaluation, post training evaluation, training section self-assessment, benchmarking, performance indicators, corrective action programme and station level trending. Based on evaluation results required modifications are implemented to the training programme learning objectives, test items, training setting, training materials, etc.

Procedures for overall SAT phases are established and clearly identify tasks, and responsibilities of managers, superintendents, training personnel and employees.

For other job positions a graded approach to the SAT process is used. The training for these job positions is not always controlled by the training section, which could lead to inappropriate training. For example, improperly designed learning objectives for training on emergency planning dose assessment software could contribute to problems during an emergency drill exercise.

The position of the training section within the Brunswick Nuclear Plant (BNP) is in compliance with the one recommended by IAEA documents. The staffing of the training center and usage of the contracting organizations for training assures that training needs are

addressed on time. The high expectations, together with strong support to the training by management, are visible in day to day life.

The interface between the training staff and the staff from other company departments is on the appropriate level, and assures that training addresses real needs of the plant and respective sections and units.

The training programmes are regularly evaluated by training programme committees (TPCs) and the training advisory board (TAB) provides oversight of the training organization and expectations for TPCs. In addition, the training section performs self-assessments of each training programme, and BNP nuclear assessment section provides oversight and bi-annual programme evaluations of the training programmes. Performance indicators (PIs) are used for training trending and represent part of training evaluation.

To assure that the instructors possess appropriate technical and instructional knowledge and skills, initial and continuing trainings for training instructors from the training section are established. Five main areas of instructor qualifications are: instructional materials developer, classroom instructor, laboratory instructor, simulator floor instructor, and simulator booth operator. The instructor may be qualified in any one or all areas.

During the observations of simulator training and examination, classroom continuing training of control room operators, classroom and workshop retraining of mechanical maintenance personnel, the appropriate knowledge and skills of instructors both in technical area and instructional skills were demonstrated.

In addition to training instructors, training can also be delivered by subject matter experts – “guest instructors” for specific topics. There is no formal requirement on “guest instructor” training on instructional skills. Only a “dry-run” demonstration session is required. The team made a suggestion in this area.

## **2.2. TRAINING FACILITIES, EQUIPMENT AND MATERIAL**

Brunswick Nuclear Plant has classrooms as well as meeting rooms that can be used for training purposes. Classrooms are equipped with all necessary training tools. At BNP the computer based training (CBT) is used for several training courses. The plant has several rooms where training material, flowcharts, operational procedures and other documentation supporting knowledge acquirement are available.

The technical training center (TTC) has several laboratories and workshops that are used for training of mechanical maintenance, radiation protection, chemistry, I&C/electrician technician, and engineering support personnel.

The workshops are equipped with all necessary training tools which support the training of the skills. There is a facility for indoctrination of the procedure connected with the entrance to the radiation area, usage of protective clothes, procedure to take off this type of clothes, and an exit procedure for radiation areas.

Training materials are of high quality. They are reviewed according to the schedule or before the course is delivered. Each trainee receives hardcopy of the training materials. The materials as well as presentations in PowerPoint are available also on web page. The training section has possibility to take photographs and videotapes. The tapes are used during the training but they are also available in the libraries of training department.

The main parts of the simulator are simulation computers, instructor station, interface, MCR panels, and an engineering station. It fulfils requirements of ANSI/ ANS-3.5 and IAEA-TECDOC-685. It is designed for training of control room operators and it simulates normal operation modes, abnormal and emergency events. The simulator is equipped with microphones and cameras, which allows recording trainee's performance. Fidelity tests of the simulator are performed annually.

The reference unit is Unit 2. To be able to properly address the differences between Unit 1 and Unit 2, simulator modules for Unit 1 operation are developed and used to simulate the behavior of normal, abnormal and emergency operation during the training. A simulator configuration control system is well established. Required simulator modifications are introduced in timely manner.

In addition to the full-scope simulator, the desktop simulator is available in the training center. It is used during the classroom training for various types of personnel to demonstrate systems operation.

Both simulators are also used for training of other job positions on site.

### 2.3. CONTROL ROOM OPERATORS AND SHIFT SUPERVISORS

Training for licensed operators is based on systematic tasks analyses. The training programmes initial and continuing fully reflect all needs and are properly structured to modules. Supportive training materials are regularly updated by training personnel.

The initial training consists of six modules: Fundamentals, Systems, Procedure Training, In Plant on the Job (OJT), Abnormal Operating Procedures (AOP)/Emergency Operating Procedures (EOP) Training, and Progress Energy Audit/Certification examination. The training programme has a good structure and progression from more simple to complex tasks. Training setting are appropriately selected mostly using classroom training, simulator training and OJT. Simulator training is used in various training modules appropriately supporting learning objectives starting with familiarization of the system, via system operation to the plant normal, abnormal and emergency operation. Evaluation of trainees is typically conducted weekly and based on results (if the trainee does not reach pass rate) remedial training is established in the topics where it is required. Before taking the US NRC examination, the plant audit exam is conducted.

Training records on both the individual trainees/employees and the training course allow tracking required information. Training records are kept in paper form and are also digitalized and available in training database. Evaluation of the training is done in full compliance with the procedure for training evaluation. Student feedback and instructor feedback are done weekly and applicable modifications to training are done almost immediately. The other required modifications are done during "regular" training program revision or prior next training cycle.

Continuing training is done six times a year for each crew and consists of retraining, information on modifications and changes, lessons learned from events at the BNP and other plants (national and outside USA) and results of plant self-evaluation. Training materials from initial training are used for this part of the training. If there are plant modifications or changes in procedures, a task analysis is conducted (if it is appropriate), learning objectives established and required training materials developed. A portion of the continuing training is

devoted to lessons learned and should serve for upgrading of the plant operation or to the avoidance of the event repetition.

Simulator training creates a part of the control room operator continuing training. Simulator scenarios for continuing training should cover required normal, abnormal, and emergency operation in two-year cycle. In addition to these scenarios the continuing training covers also modifications and changes. There are also scenarios of the events that occurred at the plant or somewhere else.

The training programmes, both initial and continuing, prior to be implemented have to be approved by training programme committee (TPC). The members of the training programme committee are operation management, experienced SME, training management and instructors. In addition to this management's participation in the training activities a shift operation manager takes part in the trainees' assessment during the simulator training or during the plant exams prior to US NRC licensing exams.

#### 2.4. FIELD OPERATORS

The training of new individuals is divided into several steps. The programme has five segments (Basic Non-licensed Operator Training (Power Plant Fundamentals), NLO Fundamentals Training, Plant Systems/Admin/Procedure Training, Additional NLO Training, and OJT/TPE provided by a series of site-specific OJT/TPE cards) and takes approximately one year. The non-licensed operator candidate may qualify on separate watch-stations – outside, turbine building, reactor building, radwaste operator, refuel qualifications. For each watch-station the respective qualification card is developed. In addition to these qualification cards, a general qualification card is developed. The candidate must pass the general qualification card. The order of other qualification cards is determined according to needs of operations department.

Once each NLO is qualified for at least one watch-station receives continuing training designed to reinforce, maintain, and improve employee job-related skills and knowledge. This training may include but is not limited to the following – review of the knowledge from previous training, changes to procedures, plant modifications, operational experience feedback, systems review, licensee event reports, significant operating experience reports, newly identified tasks, and training needs based on NLO watch-standing assessment.

The backbone part of a continuing training programme for field operators is designed for two-year period. The training is organized twice a year for four days.

The learning objectives and test items are properly designed for the initial and continuing training. Various kinds of training settings as well as training methods are used e.g. classroom, OJT, group discussion. Training materials for both instructors and trainees are developed. The training materials are regularly updated once per two years or before start up of a training course. Training records are kept both in hardcopy and electronic version on training implementation, trainees' results, and training evaluation. Results from evaluation of the training is used for further training improvement.

#### 2.5. MAINTENANCE PERSONNEL

Training programmes are in place for the following maintenance personnel: maintenance supervisor, mechanical maintenance technician, and I&C technician/electrician.

Mechanical maintenance initial training programme includes the following major topics – Orientation Training, Industrial Safety Training, Tools and Equipment Skills Training, Basic Fundamentals Training, Basic Systems Training, Plant Component Skills Training, Specialized Skills Training. These topics are covered in three blocks of training: Indoctrination Training, Fundamentals Training, and Plant Specific (Specialized) Skills Training. The training programmes for individuals are based on an Individual Development Plan (IDP). The IDP lists specific lesson titles and codes to be included in the new employee's Training Programme, which is customized on individual's prior education and experience. Parts of the IDP relating to Indoctrination and Fundamentals Training should be completed within two (2) years of initial hire date.

There are various training setting used for training – self study, classroom training, workshops, laboratories and OJT. The workshops in TTC are well equipped to support skills training.

Continuing training for maintenance personnel is conducted two or three times per year. Topics included in training are specific topics from initial training to refresher e.g. fundamentals, plant systems overview, tasks selected for continuing training, lessons learned from event in nuclear or conventional industry, performance problems (i.e. task performance, human error), plant changes (i.e. procedures, modifications), and other plant specific needs. Continuing training is also conducted by maintenance management. This training is performed as needed and usually involves immediate concerns such as procedure changes, shop practices, etc. Informal training reports may be used to document these sessions. This is considered a good performance.

## 2.6. TECHNICAL SUPPORT PERSONNEL TRAINING

The “engineering” training and the training for chemistry and radiation protection belong to the accredited training programmes. Learning objectives are derived from the analyses and are used for training programmes establishment. OJT/TPEs are established where applicable. Various kinds of training setting and training methods are used.

Training materials appropriately supports delivery of the training. The training programmes properly address also safety, ALARA and safety culture.

Training is conducted by instructors from the training department, external instructors hired for specific training course from outside of the organization or by the subject matter experts from plant. Training delivered by an external organization is verified by training staff.

Training records are properly collected and archived including training course trainee's attendance, schedule, training materials and results of training evaluation and actions taken to fix weaknesses.

So-called “backbone part” of continuing training for technical support personnel is, in general, designed for a four year cycle. It contains parts which represent regulatory requirements and these parts are compulsory and parts which can be modified based on operational experience, needs of job incumbents, and manager's requests. This keeps training programmes accurate and appreciated by staff.

Continuing training for engineering staff is organized twice a year for two or three days. Continuing training for chemistry technicians and radiation technician are organized twice a

year one week. The first portion of the training is conducted before planned shutdown for refueling, and includes any necessary outage related topics.

## **2.7. MANAGEMENT PERSONNEL**

The appropriate training for various levels of managers and supervisors is established. The training is to a limited extent, delivered at BNP but the mostly it is conducted on company level.

All managerial aspects are properly addressed and training for all levels of managers is established based of the individual periodic evaluation based on needs expressed by individuals and their superiors.

Site supervisor training, which includes senior reactor operators and operations shift manager's, is typically conducted on a quarterly basis to address the current site needs. For example, one topic in a recent session was a session on coaching skills and included a practical exercise on providing negative feedback to subordinates. One of the topics identified for the next session will focus on the employee selection process to use in filling vacancies that will be created by the voluntary early retirement program. These topics are identified by the supervisor training programme committee, which consists of the director of site operations, plant general manager, training manager, site human resources representative, and other section managers.

## **2.8. GENERAL EMPLOYEE TRAINING**

General employee training (GET) is compulsory for all individuals who can be granted unescorted access to any nuclear facility. This includes plant employees, company employees, contract employees, and suppliers. The training programme for BNP employees and suppliers consists of two parts – plant access training and radiation worker training. The shorter version of GET – 'Access Orientation Training' can be used in conjunction with plant access and radiation worker training to gain unescorted access to Progress Energy nuclear facilities.

The Plant Access Training consists of several topics such as fitness for duty, plant organization, plant administration, nuclear plant overview, industrial safety, fire protection, quality assurance programme, plant security, emergency preparedness, radiation protection.

The Radiation Worker Training consists of following topics – atomic structure and radiation sources, types and measurements of radiation, biological effects, limits and guidelines, ALARA, dosimetry, contamination, internal exposure, radiation postings, radiological alarms, radioactive waste, rights and responsibilities, radiation work permit/ALARA task, contaminated area practical exercise.

Learning objectives are established. The training course is usually delivered as computer based training along with a required practical exercise. When necessary, such as during outage preparations, the training can be taught in the classroom. The training is also supported by hardcopy training material. A specific laboratory/workshop is dedicated for practical exercise.

Retraining in this field is required once a year. If the personnel do not manage the one year interval, they are automatically disqualified and loose their unescorted access to BNP.

## DETAILED TRAINING AND QUALIFICATION FINDINGS

### 2.1. ORGANIZATION AND FUNCTIONS

- 2.1(1) Issue:** There is no formal requirement for “guest” instructors to pass the training on instructional skills which can cause decreasing of training effectiveness.

A comprehensive training programmes for training centre instructors both technical and instructional areas are developed and implemented in accordance with the respective procedure on instructor training and qualification however there is no formal requirement for training on instructional skills of “guest” instructors – subject matter experts from various plant departments – who also act as instructors in various training modules.

Despite the fact that there is some evidence about self-study on instructional skills of these instructors and “dry-run” is required this lack of formal training could result in the lower level of the training delivery and decrease the effectiveness of the training as a whole.

**Suggestion:** Consideration should be given to establishment of the appropriate formal training on how to conduct lessons and how to assess the trainee performance for “guest” instructors.

**Basis:** IAEA Safety Standards NS-R-2 3.9, NS-G-2.8 para. 5.31.

- 2.1(a) Good practice:** The ‘Training Advisory Board’ (TAB) and the ‘Training Programme Committees’ (TPCs) provide oversight and direction to the training section to ensure that training is used to improve plant performance and is meeting the needs of the line organizations.

The ‘Training Advisory Board’ (TAB) and the ‘Training Programme Committees’ (TPCs), which are sub-committees of the TAB, provide oversight and direction to the training section. They are very effective in ensuring that training is used to improve plant performance and is meeting the needs of the line organizations.

The TAB is chaired by the BNP vice president and attended by section-level management, training, and TPC representatives.

The TPCs are chaired by a line manager or supervisor and include incumbents and training personnel. They each address one or more related programmes and are the primary means of ensuring that training drives improvements in personnel performance at BNP.

When performance problems are identified that can be addressed by a training activity, or job incumbents identify additional areas where training can improve plant performance, they are documented on the TPC action plan. The action plan includes: a description of the performance improvement item, the desired outcome, action item assignments for the training interventions that will result in the desired outcome, a description of how training effectiveness will be determined, and a status/results section.



The action plan forms the core of an annual presentation by each TPC to the TAB. It is a tool for capturing and reporting improvements in personnel performance that are linked directly to training interventions.

**2.1(b) Good practice:** The training organization incorporates human performance training into all training sessions to reinforce management expectations and to improve worker performance.

The training organization incorporates human performance training into all training sessions to reinforce management expectations and to improve worker performance. For example, all supplemental workforce personnel attend two hours of classroom human performance fundamentals training and two hours of lab exercises. The lab exercises consist of faulted plant work scenarios where the worker is asked to identify unacceptable plant or work conditions (i.e., FME, housekeeping, chemical control, confined space, etc.). These faulted scenarios are typically developed based on previous outage conditions which were identified as improvement opportunities.

Supplemental workforce personnel are also required to attend pre-outage human performance continuing training which typically consists of a review of OE from previous Brunswick outages as well as lessons learned from other utility outages. Prior to the outage, the 'Human Performance Steering Committee' participated in an INPO web cast meeting where plants shared outage related human performance issues. As a result of this meeting, Brunswick learned that other plants were seeing issues with the control of supplemental workforce as well as night shift personnel in general. Based on this feedback, targeted or focused observations were performed throughout the outage with an emphasis on night shift work and work being performed exclusively by supplemental workforce personnel.

Observation of work is a key element of improving human performance. A team of individuals composed primarily of training instructors is identified each year to conduct observations prior to and during the refueling outage to recognize negative as well as positive behavior. These observations are analyzed each shift and "real time" information is provided to the management team regarding potential emerging trends.

An example of this was this past outage when the observations revealed that workers were not wearing proper hand protection in contaminated areas. This information was shared with the workforce and managers and the condition was corrected within 24 hours.

### **3. OPERATIONS**

#### **3.1. ORGANIZATION AND FUNCTIONS**

The operations department has a staff of highly proficient and responsible team members. The operational shift staff has a minimum complement of 16, divided between the two units. Five fire team members, all of whom are operators, are included in this number and shift responsibilities are clearly assigned at the commencement of the shift for both normal and emergency situations.

The organization and administration aspects of the operations department are well set out in procedures; specific responsibilities are also defined and the authority given to the operators is commensurate with these responsibilities.

Goals and objectives are established in the business plan and widely distributed via the BNP Intranet. These are effectively communicated to all of the operations staff at each training cycle session.

Rotational assignments are encouraged to allow operators to come off shift and work in other departments on site to increase their own development and also that of the department in which the operator is placed. This is seen by the team as a good practice.

Policies and programmes are proceduralised and in place. Distinct management expectations exist but these were not observed to be fully implemented at ground level. An example of this is in the area of housekeeping and cleanliness where a number of management initiatives, including a self-assessment, are evident but there is still the need for further improvements in this area.

Administrative tasks are minimized for the operations shift staff by substantial staff support including licensed operator support from the work control area for example.

The management commitment to improving safety culture is evident and this is effectively communicated to the shift crews. Safety and human performance issues take mandatory prominence at these briefings and the team recognizes this as a good practice.

The team observed management presence in the field on a number of occasions. Safety and production issues are discussed daily at the morning management team meetings.

A comprehensive shutdown risk programme exists with risk assessment team responsibilities clearly defined. The risk status for each unit is updated on a dynamic basis.

Self assessments are undertaken when considered necessary by the operations department with the required actions being produced and followed up to closure.

Both units are operated from a common control room and a clear, well understood division of duties between each unit is readily apparent. Outside of the main control room, different floor coloring is used by staff to re-confirm that they are indeed working on the correct unit – Unit 1 has a white floor and Unit 2 has a blue floor.

The interface between operations and other departmental groups was observed to be consistent with international practice.

### 3.2. OPERATIONS FACILITIES AND OPERATOR AIDS

The operational communications system is adequate and radios, telephones and a public address system are utilized.

The number of annunciators which are illuminated in the control room are minimized and an abnormal status is identified by a white magnetic strip, which is affixed to the metal panel adjacent to the alarm. The strip contains written information on the cause of the illuminated annunciator. A hard-copy log exists in the control room for annunciators which have been disabled, either through redundancy or to clear a 'nuisance alarm'.

Operator aids in the main control room are controlled through the quality assurance system used by the procedure reviewers.

Some instructional aids containing short action lists from the corresponding operating procedure and are used in the control room in the format of magnetic plastic cards and are placed on the gauge panel to support the operator in controlling the plant systems and equipment. Although the process for controlling instructional aids used by operations is effective, operating placards or instructions for equipment operated by other working groups is not properly tracked. The team recommends the plant to modify the current system to monitor active instructional aids that are applied by plant workers in different departments and working groups.

A plant process computer is used to provide adequate plant performance data e.g. historical trends on specific sensors.

A shutdown panel exists for each unit so that both units can be safely shut down to cold shutdown (Mode 4) conditions if the control room had to be vacated. Two procedures exist, one for vacating the control room in the event of a fire and another for all other instances where vacating the control room is necessary. Several licensed operators were under the impression that copies of all 'Emergency Operating Procedures' also had to be taken to the shutdown panel. This is not required and the team recommends that the plant should clarify the guidance to operators and retrain them. Remote shutdown panel (RSDP) equipment and procedures should be dedicated to the RSDP. There is a procedural requirement for two tables to be in place adjacent to each shutdown panel but no tables were in place owing to the fact that they had been inadvertently removed during housekeeping activities. They have been under order since December 2004.

Equipment isolations are easily identified in the control room by a system of labels and tags.

There are a number of plant housekeeping (which includes cleanliness) initiatives in place. These include a) 2-3 days per year where all site employees are encouraged to 'clean the site', b) a special procedure has been developed for housekeeping, c) a website is dedicated to housekeeping, d) the 'A Matter of Pride' incentive scheme where employees are rewarded for acts of housekeeping and e) a weekly team walkabout, which includes management participation where specific areas are identified on a rotational basis and the team 'cleans up' the area. The team identified a number of instances where deficient housekeeping practices still exist. The initiatives are viewed by the team as being reactive and the team suggests that a more proactive approach to housekeeping be adopted to further instill a good housekeeping culture.

### 3.3. OPERATING RULES AND PROCEDURES

The operational limits and conditions are contained in a technical specification (TS) document which contains all the necessary requirements. The plant has produced its own document, the technical requirements manual, to support the TS document. Entries into 'Limiting Conditions for Operation' (LCO) are recorded in the electronic control room log by the unit SRO. As an additional aid for the operational staff, all alarms which have LCOs associated with them have a TS reference on the associated alarm card. A history of all LCOs entered is easily retrievable from the electronic log.

As LCOs are recorded electronically, there is no visual method of displaying current LCOs in the control room. It was observed by the team that several entries into the same LCO had taken place over a period of four hours without any recognition of the LCO being cleared in the meantime. The team suggested that the plant should consider installing an LCO information board in the control room to visually display the status of LCOs.

An event occurred on the plant in which an emergency bus was de-energized. Following a review of the control room operator's log and observing actions during the period after the event, it was considered by the team that immediate identification of all LCOs associated with the event was not apparent. It is suggested by the team that the plant should consider the development and implementation of a procedure to state the specific LCOs to be entered upon loss of any emergency bus, including the reasons for each LCO entry.

There is a clear and easily understood surveillance programme indicated in the TS document.

Normal operating procedures provide support for operators (RO, SRO) in the control room as well as for field operators (AO) performing routine monitoring on equipment in service. A comprehensive set of normal operating procedures is maintained in the control room. To distinguish one set of procedures from another, Unit 1 procedures are located in yellow files and Unit 2 in blue. Furthermore all procedures are accessible from the plant computer database. The front page of each procedure contains all the necessary data including designation of the company, plant, name, procedure title, revision number and procedure level of use, i.e., "continuous use", "information use" or "reference use". Normal operational procedures are most often "continuous use" and written in the step-by-step format. The procedure includes a sequence of operator actions with reasonable level of details that reflects the corresponding level of personnel training. Before a procedure is carried-out, a team of involved personnel conducts a pre-job brief.

It is apparent to the shift personnel that procedures taken from the computer database (Passport "Procedure Revision" application) is up to date. Revised procedures are replaced both in the database and in hard copies. Hard copies are promptly distributed to the specified copyholders. Nevertheless, periodic test procedures files that are located in the control room had no indication of a copyholder.

Normally, the required copies of procedures are printed from the database and then are used to carry out actions.

In case of any procedure deficiency a nuclear condition report (NCR) is usually initiated by completing a corresponding form from the Passport database. Depending on the significance, Priority 1 or 2 is usually assigned to the issue. With respect to the minor procedural discrepancies, Shift personnel complete a procedure revision request form.

Abnormal operating procedures are compiled and maintained in the same manner and with the same attributes as normal operating procedures. There is no step designation to indicate the performance of a particular step. These procedures in some cases support another set of procedures called 'Emergency Operating Procedures' (EOPs) that provide technical guidance for the operating shift during emergency conditions.

EOPs are designed as a combination of flow-charts and ordinary text procedures that are used to perform particular actions on a system or a component. In this case, text EOPs specify the responsible reactor operator (RO) or auxiliary operator (AO) for a procedure step performance.

Some diverse methods are used for checking technical accuracy and applicability of revised or new procedures. An independent person performs the verification. The operations department has 5 procedure writers available. Validations can be performed by various methods including tabletop discussions, demonstrations, plant walk downs, or simulator scenario. Recent modifications and power uprate modifications performed at the plant have introduced many changes into plant procedures. First priority changes have already been introduced into procedures such as EOPs, abnormal and normal operating procedures. However, a high number of procedure changes are still pending, including SAMGs that are assigned as priority 3. This explains the 'Operations Red Performance Indicator Window' dedicated to the procedures.

Shift personnel both in the control room and in the field widely and effectively use alarm response procedures. These procedures are located in fitted pockets on the associated gauge boards or control panel. In case of an alarm deficiency, a white sticker is usually placed on the associated gauge board adjacent to the window with relevant explanations. However this approach does not cover alarm window deficiencies at the local gauge panels in the field. The team observed that the RSDP Drywell temperature alarm window deficiency remained unknown by field operators for a period of time and appropriate field monitoring measures were not undertaken. The team recommends that the plant establish and implement a method to identify and mark inoperative alarm windows that are located on remote gauge panels in the field to ensure proper monitoring and control of plant safety related alarms and parameter status.

The plant performs periodic reviews of procedures in accordance with the relevant procedures.

On occasion, control room personnel have no notification about procedure replacement after revision is done. As soon as a procedure is updated in the PASSPORT database it is considered valid. Within 24 hours operations clerical personnel should replace the hard copies of the procedure. However the team observed several examples of incorrect versions of operating procedures located in the plant and team recommends the plant to undertake necessary arrangements to provide consistency and accuracy in the area of controlled documentation handling.

### **3.4. CONDUCT OF OPERATIONS**

The control room operators were observed to be well trained, attentive and knowledgeable in their duties. All observed manipulations of controls were undertaken with the use of a procedure and three-way communication was utilized at all times.

Shift turnovers from the reactor operator level up to the shift superintendent (SS) were observed to be comprehensive and professional. Where abnormal plant operational conditions were observed at shift turnover time, the incoming shift briefing by the SS was conducted in a room external but adjacent to the control room. This alleviated any possible congestion in the control room. The two reactor operators for the unit were also observed to complete turnover one-at-a-time during this event to ensure that there was always one reactor operator to monitor the plant.

A shift briefing is held by the SS in the main control room with all shift personnel present, approximately ten minutes after the official turnover time.

The number of people observed in the control room during the loss of emergency bus event of 12 May 2005 was 21. The team considers this number to be excessive and suggests improvements in this area.

System and component status changes are undertaken only under the authority of a licensed senior reactor operator.

A comprehensive reactivity management programme is in use and directs the operators regarding the approach to criticality as well as subsequent power maneuvers. Guidance on reactivity control for the operator is also obtained from a reactor engineer for planned shutdowns/startups. Power increases/decreases are directed by the unit senior control room operator in accordance with the recommendations of the reactor engineer.

There is no stated time limit between the time that the PNSC authorizes plant restart and the actual time when the approach to criticality is commenced. The team encourages the plant to consider adopting a reasonable time limit between the PNSC authority being granted and the actual time when reactivity changes are made on the approach to criticality.

The importance of the foreign material exclusion programme was well known and understood by all the operational staff interviewed.

Field operations were observed to be effective in verifying system and equipment status although the team did observe that some operators were not addressing certain aspects of housekeeping and cleanliness. The team encourages the plant to emphasize housekeeping/cleanliness aspects routinely at team briefs.

Surveillance of the plant systems and equipment is carried out in accordance with plant procedures. The plant follows a structured and methodical approach in planning, preparation and implementing of surveillance activities with subsequent analyses of acceptance criteria and trending test parameters to identify degraded conditions. A comprehensive and open pre-job brief is carried out prior to the commencement of a test. An SRO usually leads the brief utilizing a pre-job brief checklist which considers all significant matters related to the forthcoming activity including important internal and external operating experience topics.

The procedure "Post Scram Review" provides guidance and requirements relative to data collecting, investigation and recommendation for the plant restart following a reactor scram. An event review team is formed to manage and complete an investigation of the plant scram and provide recommendations for plant restart including the identified direct cause of the scram, necessary maintenance and testing before reactor restart, monitoring during and after reactor restart, briefings to operations and maintenance personnel regarding possible malfunctions and finally, particular conditions for the reactor restart. The plant general

manager then authorizes the plant restart after receiving concurrence from the Plant Nuclear Safety Committee.

### 3.5. WORK AUTHORIZATIONS

The plant work authorization process is strictly arranged in accordance with administrative and work procedures and supported by an effective PASSPORT computerized tool that is widely available and used throughout the departments and working group.

Plant personnel using the appropriate PASSPORT application generates a work request. After conversion to a work order, subsequent work order package processing is performed by the coordination center to ensure that maintenance, testing, surveillance and inspection work are correspondingly authorized and carried out in accordance with established procedures. Work is planned and the work package is delivered to the work control center for approval at least 7 days prior to the scheduled work start date.

Operations personnel are involved into the work order package analysis and control room personnel maintain awareness about forthcoming work activities on plant systems and equipment. Approved work orders are analyzed by different working groups performing concurrent activities on equipment or systems prior to implementation. However in some cases it takes an extended period of time to implement some work orders due to the safety significance of the equipment or plant status. (Example: DG-1 Periodic test. N 00456183. Work request -09/10/03, Work order- 09/10/03, Work planned and approved- 03/04/04, Work printed- 05/10/05, Work performed- 05/11/05).

All modifications, which have an impact on operations, are reviewed and approved by an operations department representative. Plant documents are modified and the operations staff is trained on the modifications which impact their department.

A temporary modifications procedure exists which states that a temporary modification should either be made permanent or rescinded at the next refueling outage. A temporary change log exists in the control room. It is required to be checked on a regular basis by the operators.

### 3.6. FIRE PREVENTION AND PROTECTION PROGRAMME

The plant fire protection programme comprehensively describes organizational responsibilities and authorities, core areas, processes and process elements supporting procedures and relevant interfaces. The fire protection programme is based on the defense in depth concept. This accomplishes fire prevention, detection, and fire control, containment and suppression.

The plant fire protection systems consist of both active and passive fire protection features that include fire detection system, automatic and manual fire suppression systems and fire barriers.

The plant fire protection programme provides appropriate administrative controls and relevant procedures. This encompasses control of combustibles, ignition sources, and penetration breaching. Impact of plant modifications, fire protection and fire watch programmes, are also controlled.

The plant is required to maintain a five-person fire brigade; one commander and four brigade members to perform fire-fighting activities. The fire brigade consists of dedicated shift personnel with the proper qualification that is sustained by initial and continuing training including classroom study and live fire fighting practice.

One week of extensive training is conducted for newcomers that are assigned to the fire brigade team as well as for authorized fire brigade members at the Regional Emergency Training Service Center (Gastonia).

External (local civil) fire protection brigade personnel are qualified and licensed in accordance with National Fire Protection Association requirements.

The plant conducts annual training for the off-site fire brigades. It includes:

- Basic radiation protection
- Procedures for notification of off-site response organizations
- Site access and security
- Incident command structure

Regular drills are conducted with the local fire brigades, typically every year. These frequently include a walkthrough of plant structures.

The off site fire brigades capabilities can be improved by providing detailed information about plant facilities layouts and characteristics of the plant premises, equipment and systems.

The plant fire brigade consists of a shift incident commander (fire brigade qualified), four brigade members, and a fire brigade advisor from the control room. The shift incident commanders are trained to call for off site assistance for any fire that is not promptly extinguished. The plant design includes extensive fixed fire suppression systems, water sprinklers and Halon, however the turbine hall elevation is equipped only with manual and portable dry chemical fire extinguishers and fire hoses.

The Brunswick plant has letters of agreement with 4 local volunteer fire brigades and one full time paid fire brigade (Military Ocean Terminal – Sunny Point). The volunteer brigades are very effective in providing protection for the community, including the Brunswick plant. The insurance rating for Southport is the highest possible for a city served by a volunteer fire department. The training for volunteer fire brigade members is the same as that received by full time paid fire brigades in North Carolina. Numerous local volunteer fire brigade members are current or former Brunswick plant employees. During drills and actual fire calls, the response to the Brunswick plant has been timely (within a few minutes). The typical response for the Southport fire department is 14 members.

When at the Brunswick plant, the local brigades work under the direction of the shift incident commander. Non-plant fire fighters are led by the plant fire brigade members.

The local fire brigades were effective in assisting the plant fire brigade extinguish a fire in one of the reactor buildings in the early 1990s and they responded but were not needed for a fire in the Unit 2 main power transformer in 2000. They assisted a neighboring facility (a munitions shipping terminal) in extinguishing a munitions ship fire in 2001.



### **3.7. MANAGEMENT OF ACCIDENT CONDITIONS**

The roles and responsibilities of the operating shift during emergency conditions are assigned in accordance with procedures and appeared to function adequately during emergency scenarios on the simulator.

During shift changeover each shift member is assigned an emergency position in case of emergency conditions. The responsible auxiliary operator (AO) compiles the ASSD-ERO fire brigade staffing roster in the shift turnover log.

In case of ASSD emergency conditions, each shift member is required to arrive at one of seven assigned stations with the emergency package containing PPE, appropriate procedures and communication equipment to perform the prescribed actions. These emergency packages are located at specified locations on the way to the relevant station.

Communications between shift personnel and external bodies (government, NRC, fire brigade center, local authorities) during emergencies is well arranged and uses diverse channels and equipment.

Severe Accident Management Guidelines (SAMG) have been developed and implemented at the plant to provide guidance and specify operator actions in case of accidents beyond design basis. The guidelines are entered when the EOPs are unable to restore and maintain adequate core cooling. The SAMG format is the same as for Emergency Operating Procedures (EOPs) and represents a set of symptom-based flow charts that are readily available. SAMG flow-charts are designed to be "general picture procedure" and supported by conventional text procedures to perform particular operator actions.

For certain specific events (ASSD fires, station blackout) emergency response and recovery can be further enhanced by additional event specific procedures. For instance, procedure "Plant Shutdown From Outside Control Room" is to be used during unsafe conditions such as chlorine or other toxic gases or unforeseen emergencies which requires evacuation of the control room. Alternative safe shutdown procedures for fire accidents that may require control room evacuation also exist. Having shut down the reactors control room operators move to the remote shutdown panel and other specified locations to continue emergency restoration in accordance with these procedures. These procedures should be used with the SAMG to accomplish required actions as prescribed.

## DETAILED OPERATIONS FINDINGS

### 3.1. ORGANIZATION AND FUNCTIONS

#### 3.1(a) Good practice: Rotational assignments

The operations department uses an extensive personnel job-rotation plan to provide on-shift personnel with experience and knowledge of other site disciplines and contributes to the affected organizations ability to produce high quality products. While many plants utilize job rotation schemes for operators, this programme is unique in that it is so extensive and it places experienced operators in jobs where operational experience is useful but seldom found.

Experience in off-shift positions also aids in the professional development of personnel. Personnel are routinely rotated into and out of these full-time positions every two to three years on a staggered basis. These rotating positions provide development opportunities for shift superintendents, control room supervisors, senior reactor operators (including shift technical advisors), reactor operators and auxiliary operators and the programme provides for depth of operational knowledge in the organization.

#### 3.1(b) Good practice: Discussion at shift turnover

There is a mandatory requirement that during shift turnover, with the entire shift crew present, the first two items discussed by the shift superintendent are safety and human performance issues. New internal and external operating experience feedback topics are also discussed during the shift turnover process.

### 3.2. OPERATIONS FACILITIES AND OPERATOR AIDS

#### 3.2(1) Issue: The guidance to licensed operators regarding the procedures which should accompany the operators if the control room is to be vacated and subsequent plant shutdown is required to be conducted from the shutdown panel (RSDP) has some ambiguity.

The RSDP equipment is not as per the procedure, i.e. there are no tables at the RSDP.

A number of licensed operators were erroneously under the impression that all emergency operating procedures are to be carried down to the remote shutdown panel, should the occasion arise that main control room evacuation is necessary. A review of the procedure illustrated that during actual implementation, any required procedures are described in the body of the implementing procedure.

Any delay in vacating the control room by collecting unnecessary documents could negatively impact safely achieving control of the plant from the RSDP.

**Recommendation:** The plant should clarify the guidance to operators and retrain them. RSDP equipment and procedures should be dedicated to the RSDP.

**Basis:** IAEA Safety Standard, NS-R-2; para.5.11.

- 3.2(2) Issue:** There are a number of instances of deficiencies in cleanliness and housekeeping practices in some locations across the site.

Some of the observations of the team included deficiencies in general cleanliness and housekeeping in, for example:

- Essential service water building,
- U2 spent fuel pool floor,
- Diesel driven fire pump and fuel oil tank room.

Deficiencies in housekeeping can cause damage to equipment and could result in personnel injury.

**Suggestion:** The plant should take a more proactive approach to housekeeping practices across the site.

**Basis:** Draft Safety Guide on 'Conduct of Operations in nuclear power plants; para. 7.16.

- 3.2(3) Issue:** The plant process for controlling instructional aids used by operations is effective, however operating placards or instructions for equipment operated by other working groups is not properly tracked.

The team noted, for example:

- The procedure for the normal power supply to supplemental fuel pool cooling secondary pump system has no identification.
- In turbine hall (70') there are two documents placed on a bulletin board outlining the allocation of the turbine parts throughout the turbine hall with no identification numbers or any other supportive formal data.
- In the Diesel Driven Fire Pump compartment, the pump Manual Start-up Instructional Aid (MSIA) (number 0 1186) appeared to be wrong. The MSIA is technically current with the procedure but the database that tracks the aid number appears to be incorrect.

Use of undocumented instructions may cause incorrect actions and challenge safe and reliable functioning of plant equipment and systems.

**Recommendation:** The plant should improve the current system to monitor 'Active Instructional Aids' that are applied by plant workers in different departments and working groups.

**Basis:** IAEA Safety Standard NS-G-2.2 para 8.1, para 8.6 and para 8.7

### 3.3. OPERATING RULES AND PROCEDURES

- 3.3(1) Issue:** There is no open method of displaying current limiting conditions for operation (LCO) in the control room and there is no current immediate capability for identifying all LCOs emanating from a loss of 'Emergency Bus E1' event.

This was indicated by 'late entries' into the SRO log during the 'loss of Emergency Bus E1' event of May 12, 2005 at 4:11am and the following narrative.

A log entry at 7:00am on 12 May 2005 states that 'Unit is in 3.0.3 (OGP-05 in progress) due to loss of all leakage detection systems (TS 3.4.5)'.

According to the operator log, LCO 3.0.3 was only entered into at 8:46am and actions only logged as commencing at 8:53am, with actual power reduction commencing at 9:48am.

There are two separate times when LCO 3.0.3 was logged into the Operators PC log as being entered i.e. 7:00am (shift status) and 8.46am with power reduction actually commencing at 9:48am.

LCO 3.8.7 was identified (log entry at 4:11am on 12 May 2005) as the LCO which was applicable immediately after the loss of emergency bus E1. It did not appear that LCO 3.4.5 was immediately identified as being more limiting than LCO 3.8.7.

Without recognition and awareness of limiting conditions for operations which are applicable in certain plant conditions, the plant may not be operated in accordance with the design assumptions and intent.

**Suggestion:** The plant should consider installing an 'LCO information board' in the control room to provide an open method of displaying current LCOs to openly display to all control room staff applicable LCO's. Some plants provide this information which includes appropriate headings such as LCO title, date and time LCO entered, required actions and date and time when the required actions should be achieved. This would ensure that all operators are immediately aware of the declaration of an LCO, the time it was declared and the required actions with associated times.

**Suggestion:** To ensure full capability for identifying multiple LCOs emanating from a single event such as loss of an emergency bus, the plant should consider the feedback of the operating experience from this event.

**Basis:** IAEA Safety Standards, NS-G-2.2; para. 6.1.

**3.3(2) Issue:** The plant document distribution system does not always ensure that correct versions of operating procedures required at various locations are updated or removed from service properly. The plant PASSPORT database procedure revision application is an effective tool to ensure proper revision of plant procedures are used, however the plant experienced a number of deficiencies with the operating documentation.

The team noted:

- A controlled copyholder book containing 5 out-of-revision AOPs was found not removed from the approved copyholder list,
- some operating procedures and drawings have no indication of a particular copy holder,
- some procedures have a controlled copy stamp with necessary information; approval date, effective date, signatures of authorized persons, whereas other do not.

Use of incorrect versions of operating procedures or drawings of different kinds may challenge shift personal actions during possible emergency conditions and cause adverse consequences to the plant.

**Recommendation:** The plant should support the document control system including the 'PASSPORT Procedure Revision Application' with necessary administrative and/or organizational controls to provide consistency and accuracy in the area of controlled copy handling.

**Basis:** IAEA Safety Standard NS-G-2.2 para 8.1, para 8.6, and para 8.7

- 3.3(3) Issue:** The plant practices do not ensure annunciators with deficiencies in remote locations are properly identified and marked, although these annunciators are clearly identified in the main control room.

The team observed:

- Remote shutdown panel drywell temperature alarm window inoperability was identified on 12 May 2005; however the remote alarm window was not marked off such that the field operator was aware of the deficiency.
- The radwaste control operator was unaware that two annunciators were impacted by field deficiencies.

Monitoring and awareness of the safety related parameters and signals in the control room as well as in the field assure the plant personnel are aware of the current status of the plant systems and equipment and keep them ready to respond promptly in case of events that affect safe and reliable operation of the units.

**Recommendation:** The plant should establish and implement a method to identify and mark inoperative alarm windows that are located on panels in the field to ensure proper monitoring and control of plant alarms and parameters status.

**Basis:** IAEA Safety Standard NS-G-2.2 para 8.3, para 8.6, and para 8.7.

- 3.4(2) Issue:** The number of people observed in the control room area at certain times is considered excessive when the plant is in an abnormal operational condition. The attention of the operators could be adversely affected by distractions.

21 personnel were observed in the main control room on May 12, 2005 at 6:30am.

The licensed operators are required to maintain safe control over the plant at all times and this control could be adversely affected by distractions caused by an excessive number of personnel in the control room during abnormal operating conditions.

**Suggestion:** The plant should consider further limiting the number of personnel allowed to enter the control room area to ensure that the unit operators are not distracted by an excessive number of personnel in the control room during abnormal operating conditions. It is suggested that the number of entrances available for access to the control room be reduced from three and to also designate only one individual, for each unit, to permit access into the control room.

**Basis:** IAEA Draft Safety Guide on 'Conduct of Operations in nuclear power plants; para. 5.7.

## **4. MAINTENANCE**

### **4.1. ORGANIZATION AND FUNCTIONS**

Nuclear safety and quality are well described in a document applicable to all the Progress Energy fleet. A document was developed for maintenance application under the name of "Maintenance Performance Behaviors, applicable to BNP". Work order implementation and completion followed by observation and feedback performed by superintendents, supervisors and project managers are defined. Independent or peer checking is defined as well as concurrent verification and communication. Clearance requirements and practices are also defined. Supervisors document each week observations and provide coaching and evaluation on performed task.

A large set of maintenance performance indicators exists and are well developed. Goals, objectives, results and trends are posted, and promoted. The maintenance managers follow closely the trends and adequately address corrective actions after analysis of the results. A monthly key performance indicator (KPI) report is issued showing results and trends. For the month prior the OSART mission all maintenance KPI are in "green". Site rework target was lowered due to good results. All types of rework are analyzed by a commission to address effective corrective actions. Human performance index tracks the human errors. The actual value is 2 actions for 10 000 hours worked for a three months rolling average with a target at 8 and a stretch limit at 5. On-line leak KPI reaches the target at 30 items tracked on work orders (WO). Nevertheless, the 'Maintenance On-Line Backlog'(corrective maintenance and effective maintenance) is 635 items for a target of 1000 for two units. This on-line back log does not include all maintenance activities postponed or planed for the next outage, which is tracked as a separate KPI.

Staffing of maintenance department is well sized with about 220 plant employees for two units. The population is supplemented with fleet employees and contractors during the outage. The overall structure of the maintenance department is defined in the maintenance manual management. The procedure "Maintenance: Conduct of Operation" has a chapter dedicated to responsibilities for all positions. This document cannot be considered as list of detailed job descriptions, which can help maintenance management to develop the training programme for each technical position adapted to individual's background and experience.

Training volume and efficiency is well planned and followed by maintenance staff. A continuing training review was performed in 2005. "Training News letters" includes operational experience feedback (EOF) such as INPO SER, INPO OE, plant and fleet feedback.

Interface with other fleet plants and corporate organizations are clearly defined. Various meetings create links between maintenance and other plant groups (e.g. operation) on a daily basis.

Inside the maintenance department different groups exist such as special project groups; refuel floor; motor operator valve team; air operated valve team; manhole upgrade team; which allows and increases the communication between specialists.

Interface with operation is described in various documents and developed in different areas for example into the work management process. Interfaces are solid and in both ways. Duty crews also attend operations Shift meeting on night shift and during week-ends.

Management efforts have been effective in fostering a culture that promotes good teamwork, focuses the staff on the operational needs of the station, and fosters a healthy work environment. The team developed a good practice in this area.

#### 4.2. MAINTENANCE FACILITIES AND EQUIPMENT

Mechanic shop, electrical and instrumentation and control shop, test shop, the relay and 480Vac breaker test shop, diesel maintenance shop, decontamination room for maintenance tools, etc. are satisfactorily equipped. The snubber maintenance and repair shop is considered very well equipped and well managed. Nevertheless, several observations were made during the two week surveillance tours of the maintenance facilities regarding aspects of the housekeeping and cleanliness.

The training center is properly equipped with a lot of mock-ups for electricians, mechanics and I&C usage. Industrial safety purpose, scaffolds and FME programme, are other stations used to develop skills in theoretical and practical matters.

Focusing on the battery rooms, the team made observation that potential risk of H2 explosion exists inherent to the equipment installed. The plant is encouraged to analyze this risk and consequently improve the battery room. The team also proposes a detailed suggestion to improve the working conditions to provide additional barriers for protecting personnel and equipment during maintenance work activities.

Tools and equipment are stored, labeled, maintained, and all in sufficient quantity, nevertheless in the hot tool room, tools were stored improperly with boxes stored on top of the cabinet.

The warehouse is correctly maintained, the housekeeping is good and equipment is easily retrievable. Personnel are aware of chemistry issues such as chlorine, fluorine and sulphur and the necessity to have a questioning attitude on each chemical item. Sub-quantity or chemicals are at disposal on a self-service system.

The calibration lab (Measurement and Test Equipment Lab. = M&TE) is well equipped, maintained, house kept and used. The records of the past results on calibration and also the activities performed by the tools or equipments are easily retrievable. Equipment and dedicated staff are sufficient to calibrate 100% of the I&C and electrical; and mechanical tools. Operators are very well experienced and knowledgeable nevertheless their qualification is based only on their experience in the plant, the benchmarking they perform and the training delivered by suppliers each time a new calibration equipment is purchased. Their qualification is regularly re-evaluated to ensure that they meet the best state of the art in their specific area. A self-assessment was performed recently (followed by a high quality report) and few correctives and management actions were developed and addressed properly.

#### 4.3. MAINTENANCE PROGRAMMES

Preventive and corrective maintenance programmes, scope and frequencies are appropriate and based on the regulatory requirements. Activities involving correctives actions are mainly addressed in timely manner, nevertheless the result on the key performance indicator for total maintenance on-line backlog shows that corrective actions need continual attention from the maintenance management.

Predictive maintenance is developed in the areas of vibration; thermography; and oil analysis. Good programmes and good involvement of the engineering and maintenance staff were noted by the team; nevertheless the team encourages the plant to equip more selected plant equipments in order to have a comprehensive programme and a good quality level of application of this programme. Results are recorded and tracked properly. OE is included in the control programme.

At least 32 programmes address the ageing management applied on passive components and active equipment (including structures). All are in accordance with NRC requirements and used to prepare the next licensing process for the life extension programme. These include among other things: maintenance rule programme; preventive maintenance; predictive maintenance; environmental qualification programme; reliability valve programme; in-service inspection and testing programme; BWR stress corrosion cracking, flow accelerated corrosion (FAC) programme, reactor vessel surveillance programme, etc. The team considers this as a good practice in the specific area of "coating" programme.

The lifetime management programme is prepared by the engineering group and mainly implemented by maintenance during operation or outage periods. This programme is totally comprehensive and majority is described on uniform fleet documents. Nevertheless, the effectiveness of the application of these programmes is not fully visible on site and the team recommended improvements in this area regarding long-term problem with concrete spalling, corrosion aspects and leak issues.

#### 4.4. PROCEDURES, RECORDS AND HISTORIES

Procedural use and adherence governs the management of procedures for the fleet. A procedure revision request is issued systematically to evaluate the extent of the change and sponsors are clearly designated for following the safety and technical review; the environmental aspect of the change; and approval of the content. The team found that changes of procedure are well organized and easy to follow through the computer application. Procedures are retrievable and traceable through the current computer application or by micro-fiches or films. All searches are accessible by any employee, the satellite documentations are in free service.

The content of procedures reviewed by the team in electrical and mechanical area are clear, concise, and contain adequate information technically correct with clear acceptance criteria. Nevertheless procedures do not have the approval and revision date printed on it. This is the duty of the maintenance worker to verify that he holds the last revision and this has to be checked every 7 days. Nevertheless the maintenance management encourages the workers to hand write the date of the verification on the procedure. Procedures are followed as required.

The plant is focusing on human performance topics and maintenance management re-enforces its expectations applying the plant strategic plan, involving its senior managers in the cycle training, and re-enforcing safe work practices by improving and advertising lessons learned



from benchmarking. Several examples illustrate this effort: planners preparing work orders take into account OE reports developed by INPO and a clerk preparing the work package inserts systematically the OE document into the work package. An "OEF news letter" is issued to the staff. Meetings, including management and section meetings, Pre-job-briefing, have guideline, which include human performance and safety topics. Performance indicators are developed in this area and are discussed between managers, supervisors and work teams. The team recognizes that the OE programme is well developed in the maintenance department.

Temporary changes of maintenance procedures are minimized and acceptable only if minor change and strict conditions are followed under requirements written in procedures. Any temporary change has to be approved by supervisor and operations on a specific form. In accordance with operating practices, temporary changes are tracked by nuclear condition reports or adverse condition reports.

Two employees, plus contractors, if needed, organize maintenance file history and enter data from the result of the maintenance activities to the computer system. Almost no backlog exists in this area. Maintenance history and records are easily retrievable and properly secured. Access to the vault where central documentation is archived is limited, controlled and under surveillance. The housekeeping in that area is very good. Temperature and humidity are correctly followed and recorded.

#### 4.5. CONDUCT OF MAINTENANCE WORK

Maintenance staff is trained with operation staff on clearance process; maintenance staff is able to perform their own evaluation of the clearance adequacy. Several work groups (I&C and mechanicals) were questioned and good responses were obtained on how to verify clearance adequacy for maintenance intervention. Two operators have to evaluate the adequacy of the clearance request. In case of clearance for breakers two OPS personnel prepare the clearance and two people control the hanging of the clearance.

The 'Fix-It-Now' team (FIN) is a multi-discipline work and self sufficient group designed to address emergent plant equipment issues and validation of all identified equipment deficiencies. The team recognizes this as a good performance.

Additional qualification duties enhance the support of plant performance and allow the Maintenance craft to independently perform supplemental duties that have previously been assigned to other work units. These duties/qualifications allow for an increase in efficiency and responsiveness to operational needs. The team evaluated this as a good performance.

Focusing on field activities, the team notes that at the end of the diesel outage, traces of residual oil leak were not cleaned in the infra-structure frame of the diesel. A combination of weepages, unplanned leaks, "design" leakage are considered excessive by the team on key safety equipment.

Also, during the preventive maintenance on an air check valve on the system to start up the diesel, the team observed maintenance workers climbing on plant equipment. This is not according to international good maintenance practices.

The team observed a preventive maintenance activity on batteries. The supervisor conducted an efficient and well organized pre-job-briefing where the questioning attitude was emphasized and the maintenance team showed lot of interest on the safety application of their

task. The activity was performed by two technicians and supervised by a third person who observes and provides feedback. The procedure was followed step by step with no rush. Technicians were questioned and their knowledge was evident. Nevertheless several remarks were provided by the team on the procedure. The team developed a suggestion in that area.

Frequently, mock-ups developed by the training center are used to train technicians before performing a maintenance activity in order to maintain a high level of proficiency and to remind them of the main difficulties, to re-enforce operating experience and to reduce activity duration for ALARA purposes.

A well designed FME cabinet is used to store FME equipments. They are also present for use in several areas of the plant. The FME programme looks good and is well known by staff. The training re-enforces this practice. Nevertheless in a few instances the team made remarks to improve this program such as in the vicinity of the spent fuel pool after a major activity or in the procurement storage building (see paragraph 4.8). Prompt actions were taken by the plant management to correct some items identified.

After every maintenance activity, data is collected manually on the data sheet present in the maintenance procedure or package. Calibrated tools are correctly recorded. When data is entered into computer by maintenance personnel educated for that purpose, the system engineer uses the data, for trending and if necessary initiates corrective actions. For each problem identified regarding the expected results, the maintenance technician informs his supervisor who takes immediate action to inform the system engineer for further research, action plan and if needed corrective actions.

Several instances were identified for enhancement in industrial safety: chain on the top of a ladder missing; no sign "exit" is posted in the lube oil storage room; lifting sling left exposed to atmosphere – U2 resin hoppers on radwaste roof; a fiberglass fuse puller was found above a breaker cabinet in the battery room; etc.

An industrial safety issue found by the team in maintenance area is the management of the gas cylinders. The equipment at the disposal of the worker to store temporary gas bottles and carts to carry the gas bottles does not allow workers to do their task in a consistent and professional manner. The team suggested improvements in this area.

#### 4.6. MATERIAL CONDITIONS

The material condition of some systems and components need improvement. The team found a few examples in different areas where deficiencies exist. The team suggested improvements in this area.

Once a week, field walkdowns are performed by senior managers. Observations are reported, recorded, analyzed and trended. These walkdowns are performed by multi-disciple groups and have a positive impact on material condition and housekeeping and the cleanliness level of the plant premises and external areas.

#### 4.7. WORK CONTROL

The clearance programme and organization are well done and the relationship between operations and maintenance is a model of good team work. Clearance planners work very close with maintenance staff. Nevertheless previous internal OE indicates that a few work order packages contain inaccurate or inadequate information. The plant especially the maintenance department developed action to prevent recurrence (training, OE development and communication, etc.) and today the results appear to be effective through the team observation.

The maintenance department demonstrates a sense of ownership of on-line (and outage) scheduling. Maintenance is involved on many levels in the development of the on-line schedules and outage schedules. The maintenance supervisors are directly involved with the on-line scheduling process by reviewing the schedules and providing direct feedback to the schedulers and providing input into a man-hour schedule. In addition there is also a 'Just in Time PM' review that takes place to review the PM's in the schedule. This review is performed by a multi-discipline team including the PM programme manager, representatives from maintenance, system engineering and operations. This team will review PM's and determine whether the PM frequency can be adjusted based on history, performance, rework, commitments and operating experience. The team evaluates this practice as a good performance.

#### 4.8. SPARE PARTS AND MATERIALS

All responsibilities are described in procedures and the procurement organization is efficiently supported by engineering. A computerized system is used (Action/Awareness/Alert) to communicate data or requests between the procurement group, the procurement engineer and the corporate level. The control of receipt, storage, associated documentation, and the traceability are effectively organized.

The team reviewed several products to verify adherence to material safety data sheets on the usage of the product and verification of the purchase order to validate the chemical control standards (chlorine, fluorine, and sulphur). Several examples were chosen, no discrepancies were found. The team notes that, in accordance with the USA regulation, EPRI documents, and material evaluation requests, the procurement department can upgrade the quality of a piece of equipment from class 4 (non quality equipment) to class 1 (safety quality). Only critical characteristics are required to be controlled. The team observed the verification of the quality of the material using a piece made of stainless steel (SS). The electronic device coupled with a gamma detector is able to analyze the exact quality of the SS (e.g. SS316). The device calibration was made using a titanium standard. This is an acceptable practice, nevertheless the team proposes to consider utilizing a standard which is close or identical to the equipment material being tested. The team made a remark that the total process of dedication to up-grade equipment and spare parts (class 4 to class 1) should consider additional effective surveillance and control of the overall process.

Adequate material management facilities exist, the receiving and the distribution areas are well separated. Non-conforming or damaged spare parts are stored separately to prevent miss usage. All packages are labeled with different color codes and the computerized traceability is effective. Flammable and hazardous materials are properly controlled, labeled and stored. Oil barrels are stored on berms and no leaks were detected. The team notes that the procurement storage buildings, including the storage for oils and chemicals, are not equipped with

permanent fire protection circuits nevertheless extinguishers are in place. No sump system is in place in the procurement warehouse to collect spills and to reduce the effect of an incident to the environment. The team advises the plant to consider potential consequences.

Plant procedures do not require that pipes, conduits and tubings be protected by capping or plugging under certain storage conditions. Some of them are equipped with caps, others are not. The team advises to place emphasis on the FME programme and reinforce the usage of cap or plug for tubing as well as for other equipments.

Environmental conditions and shelf life (30 days before the life time expiration) are timely controlled by material personnel. Documentation attached to safety related equipments is verified during the procurement receiving process by qualified individuals (certified by QA/QC department) and are recorded and stored in a safe documentation area. Maintenance is performed timely on long term storage equipment and material (oil change, motor rotation, etc.). Defective or non conforming equipment is placed "on hold" during the engineering analysis and returned. The documentation can also be updated under a procurement engineering evaluation.

#### 4.9. OUTAGE MANAGEMENT

A procedure "outage planning and implementation" describes the organization and the responsibility of key personnel such as the shift outage manager (SOM) who prepares, leads, and analyzes the outage. All other representatives from different departments report to him. Facilities (central location) and equipments (office, meeting room, video, etc.) are well furnished for allowing good communication (information, order, feedback); teamwork; surveillance and control. Outage documentation such as organizational chart, schedule, risk analysis, are well prepared in advance and easily retrievable.

Maintenance department has a total of 18 representatives acting as contractor coordinators. About 45 different contract companies work with the maintenance department. Daily and weekly meetings or interfaces are established to ensure contractor oversight.

Specific training programmes are developed before the outage and employees and contractors are required to attend. Personnel qualification is tracked in a friendly useable computer application named 'Passport Personnel Qualification database' (PQD).

The long term planning is governed by procedures approved by the project review group which authorizes project implementation. A key equipment list provides priorities on activities to be performed. Projects and works activities are both integrated in the site schedule and reviewed for compatibility and risk. Scheduled scope is identified and the schedule frozen at a specific date. Additional activities have to be evaluated and processed using the outage scope change request.

Outage risk assessment program and risk analysis (according to BNP Outage risk management guideline) are done by a team including SRO. Five risk functions evaluated: reactivity control, water inventory control, decay heat removal, electrical power and secondary containment. The results of the assessment are presented to the plant nuclear safety committee. Several computerized scheduling systems are utilized by the outage scheduler with high level of quality and confidence. Scheduling uses Project View software. Work package planning status and closure is performed in Passport work management, and uploaded into Progress Reporter (status of activity) twice a day adding comments from implementation groups. All these tasks are performed to assure that risks are evaluated and

the schedule is workable. Workforce resources are effectively allocated to support schedule activities. Any unplanned or rescheduled activities are re-assessed for risk. The team considers this a good performance.

ALARA goals and estimated total dose is evaluated from the most elementary activity to the most dose intensive global project. The total dose is followed daily and action plans are developed in case of deviation from the objective. Every dose is associated with an elementary task. For every activity greater than 1 Rem (10 mSv) detailed ALARA plan is developed and evaluated. According to procedures, all activities with dose projections greater than 5 Rem (50 mSv) must be approved by the ALARA Committee. Although, accessibility or maintainability modifications and permanent installation of shielding in the drywell are performed, dose reduction still needs improvement if the team refers to the two last refueling outage results. Efforts to reduce the global dose need to be continued. The team encourages the plant to continue in the direction to reduce the total outage exposure.

A comprehensive self-assessment review is organized to review outage performance followed by corrective action and management decisions. This document, which is the last milestone of the global outage schedule, has a major input on the operating experience for the plant and the nuclear fleet for future outages.

## DETAILED MAINTENANCE FINDINGS

### 4.2. MAINTENANCE FACILITIES AND EQUIPMENT

**4.2(1) Issue:** Protection of personnel and equipment in the plant battery rooms can be improved based on international operating experience.

While observing maintenance battery room (U2 2A-2, 2A1 Elec. 23' Batteries room) the team noted opportunities for improvement in personnel and equipment safety barriers.

- There are no additional insulating materials positioned on the floors to protect personnel performing tests, doing rounds or housekeepers from the potential for shock hazard.
- The room is designed as a berm. There are no plugs installed in the floor drains to avoid high concentrated strong acid ( $H_2SO_4$ ) leak to enter into drains and sump in case of battery failure.
- The grids of the floor drains are color coded. However in the same room different color codes are used leading to inconsistency of the practice: one is green (non contaminated storm drain) the other one is dark blue (dirty radioactive waste).
- Housekeeping looks good in the battery rooms; nevertheless there are several locations on the floor where the coating is degraded.
- The plant uses "distilled" water purchased from a vendor to fill the battery cells as needed. The purchased water was sampled and compared to the water available in the chemistry lab. The chemistry lab demineralized water is of a higher quality than the vendor supplied water. The maintenance department should utilize demineralized water produced by the plant chemistry lab which is regularly evaluated and the results of analysis are tracked.

Measures to enhance safety in the event of battery failure will reduce potential for personnel injuries and damage to piping, electrical cabinets and electrical pumps.

**Suggestion:** The plant should consider analyzing the setup of the technical and the safety equipment inside the battery rooms taking into account international operating experience in order to provide better protection to the plant workers, and plant equipments in case of potential  $H_2$  explosion or in case of leak of lead acid batteries (120 V and 24 V) to minimize the consequences.

**Basis:** IAEA Safety Standards NS-R-2, Feedback of Operating Experience, para 2.22.

### 4.3. MAINTENANCE PROGRAMMES

**4.3(1) Issue:** Deficiencies of certain systems, structures, and components is evident at the plant due to aging and saltwater conditions. The corrective action plan does not address in a timely manner all deficiencies already reported, tracked, recorded and evaluated. The rate of corrective actions is not appropriately balanced with the rate of deficiencies identified. The team recognizes that the plant has developed a

comprehensive programme to follow corrosion issues, and has work forces allocated to this programme. The plant already has several records on the following facts and some of them are already planned. Nevertheless the presence of such a number of ageing deficiencies needs to be treated in a timely manner.

- Concrete from north side of U2 reactor building found on AO room roof appears to be coming off corner of building about 10-15 meters above roof – other concrete debris are observed on the ground. A piece of concrete fell down on the path to the control room. According to the plant counterpart the problem and explanation are well known by plant management but still not yet solved (AR 158555).
- In several locations around concrete building of the spent fuel pool, equipments fixed to the concrete wall (supports) are very corroded and some concrete iron are apparent and rusty.
- The post accidental sampling system (PASS) has magnetic valves, with some support and pipes corroded. This appears to be due to excess of humidity in the air of the ventilation system.
- General corrosion of the circulating water traveling screens and frames.
- The drainage systems in the plant both units are generally corroded: storm drains close to the control room on both units.
- 117' U1 West side reactor building refuel floor – cracks and loose floor coating
- Surface corrosion on actuators of scram control rod valves
- Floor in the radiation area hot maintenance shop with a damaged coating.

Without implementing appropriate and on-time corrective actions, the status of the system, structure and components could be further degraded by the ageing process and difficult environmental conditions.

**Recommendation:** The plant should review, and modify as necessary, its corrective action plan to ensure adequate management of the ageing process on system, structure and components and programme to detect, track, record and schedule issues on material condition. Work orders and condition reports should be initiated to document and correct material condition deficiencies that are identified. The plant should conduct follow-up actions based on the safety importance and severity of material condition items.

**Basis:** IAEA Safety Standards NS-G-2.6 paragraphs 2.12; 4.3; 4.5; 4.21; 6.12; 7.6 to 7.8; 9.20; 9.30;

NS-G-2.4 paragraphs 6.42; 6.77 to 6.78; Technical report series 338: Methodology for the management of ageing in the nuclear power plant component important to safety

**4.3(a) Good practice: Programmes developed to track, prioritize and schedule coatings.**

Environmental conditions and normal wear contributes to degraded conditions of components and structures. To maintain structural integrity of these components, a 'Maintenance Coatings Programme' was developed and implemented. The objective of this programme is to provide logical and timely preservation of components which aids in inhibiting accelerated breakdown of the components while promoting equipment reliability. The maintenance coatings programme manager has the responsibility to ensure compliance with the requirements of the coatings programme. This includes surveying areas or zones throughout the station and entering the surface quality, environmental grade, and digital photographs of the zones in the database. An Electronic coatings program database was developed internally within maintenance and has become instrumental in establishing priorities, frequencies, budget, and resource requirements. Calculations are performed and reports are generated to provide accurate information. The results of the programme and electronic database are key elements to perform improvements in the condition of areas, components, and equipment and to have an efficient recording system.

**4.5. CONDUCT OF MAINTENANCE WORK**

**4.5(1) Issue: In process staging and control of gas bottles, and some of the equipment used to store and carry these gas bottles are not always done in a consistent best manner.**

Although the national requirements (OSHA) only specify that gas bottles must be properly secured in stand and on carts, the industrial safety practices in the plant need to be more consistent and rigorous. Facts are gathered showing that actual practices have room for improvement. There are no instances where personnel and equipment were in immediate danger.

- Gas bottle attached to a air ventilation grid in mechanical shop,
- Gas bottle secured inconsistently with one or two chains on different areas, or one or two nylon ropes.
- Outside building at the entrance of controlled area there are 11 gas bottles locked together in non professional way,
- Gas bottle found on a stand outside in the controlled area near AOG building west side had no label, was rusty, and shows a very faded code color paint, but this gas cylinder was secured,
- Inside Unit 2 turbine building front standard area, a gas cylinder is roped up and secured to a metal frame with iron wire. This bottle has been in this location (70' U2 TB front standard) for some time.
- A gas bottle cart is in very bad shape almost out of usage and not tagged as defective equipment,
- A few gas bottle carts do not have adequate housing for the gas bottle nor are equipped with secured chains.
- Gas bottle staged on a cart in the makeup water treatment building for more than 24 hour period after completion of use without being removed.
- The gas carts used in the main warehouse inside the controlled area and the carts stored for worker usage near the main gas storage area are in good shape. This



practice needs to be consistent all around the plant for safe usage by all plant and contractors staff.

Without adequate attention to the management of the gas bottles, carrying and storing gas bottles improperly could lead to injury of personnel. An incident (fall of gas bottles) could cause damage to equipment and company property.

**Suggestion:** The plant should consider improving the management of gas bottles and the safety equipment at the disposal of the worker to store and carry gas cylinders.

**Basis:** IAEA Safety Standard Series 50-C/SG-Q para 316; NS-R-2 para 6.7, 6.11, 2.30; NS-G-2.1 para 6.1, 6.6, 6.8, 6.15.

#### 4.6. MATERIAL CONDITIONS

**4.6(1) Issue:** A number of material condition deficiencies exists requiring continued attention and corrective actions in order to maintain a high standard of material condition across the site.

During the first plant tour, the team noted the general material condition was good. Nevertheless, looking more closely the team found a few examples in different areas and topics where material condition needs additional focus. A number of these items were previously identified and have activities already planned to correct:

- Duct tape used to fix air conduct in the connection of elements, in level 117' fuel pool,
- Duct tape used on electrical conduit in AOG Building above control panel.
- Fire pump 2 FP-LV-1431-2 the packing box is much corroded probably due to long term leak. The leak was fixed without changing corroded pieces, (WO 709809)
- Opened thermal insulation on suction line for heat exchanger 1CRRBCCW
- Temporary cable concerns:
  - Numerous minor load cables (cameras, phones, computers, etc.) are installed for “long” time. These modifications look still like temporary installation.
  - RB U2 Cable tray with cover installed by design but not properly positioned (37J/DA)
  - Brunswick remote radiation monitoring system is a permanent modification. The coax cables (more than 6) are secured around H2 pipes used to cool the generator.
  - Potable water hose near valve 2 PWT-V32 has corroded supports, which do not adequately support the pipe, (WR 194140)
- Corrosion caused by contact of dissimilar metals:
  - Valve 2-CAC-HV-28 (demin. water tank): badly corroded.
  - Nitrogen fill out tank 2-CAC-HV 30: support corroded.
  - Auxiliary surge tank: all bolts to anchor the tank in the floor are corroded (body of the tank in SLS, nuts in CS, the stainless steel “protection” exist but is insufficient to avoid galvanic corrosion),

- Oil leaks:
  - On the crane of the reactor building U2 (20 feet) minor wee pages – a catch container has been installed,
  - There are a number of oil leaks associated with components on the diesel generators.
  - HPCI booster pump U2 elev 17'
  - A number of oil leaks beneath pumps in U2 reactor building
- Water leak:
  - Excessive river water leak at the doors of the circulating water traveling screens,

(1-SCW-1D-CW-TRVL-SCRN & 2-SCW-2D-CW-TRVL-SCRN) The activity is planned and the job is on going.

Deficiencies in material condition, not being repaired in a timely manner could become precursors to the development of more severe material conditions in the plant.

**Suggestion:** The plant should consider reinforcing its expectations to maintain a high standard in material condition by detecting, reporting and correcting deficiencies in a timely manner.

**Basis:** IAEA Safety Standards [NS-R-2; 5.17; INSAG-12; 3.3.9, 116; INSAG-13; 92 - 93; INSAG-15; 3.5, Safety report series No. 11; 7.1.4; NS-G-2.8, Appendix 1].

## **5. TECHNICAL SUPPORT**

### **5.1. ORGANIZATION AND FUNCTION**

At the Brunswick Nuclear Plant (BNP), technical support is performed by the Brunswick Engineering Support Section (BESS), with assistance and guidance of corporate department nuclear engineering and services.

The primary responsibility of BESS is to provide technical leadership and engineering support to BNP as defined in the 'Quality Assurance Programme Manual'. This responsibility includes providing proactive engineering services, implementing engineering programmes, owning and maintaining the design/license basis and performing plant modification.

BESS consists of three work groups; system engineering, design engineering and technical services. System engineering group monitors system health and ensures safe and reliable operation; Design engineering group is responsible for maintaining design basis and performing engineering changes; and technical service group has the lead for engineering program management and problem resolution. The organization structure with systems, design and technical services is intended to enable BESS to more effectively use personnel skills and resources and to meet plant needs with process/program alignment.

The corporate Nuclear Engineering and Services Department (NESD) provides technical leadership and engineering support and services for the operation of the Brunswick, Crystal River, Harris and Robinson Nuclear Plants. NESD's functions include administration of engineering programmes, project management, nuclear fuel management and design and probabilistic technology services.

Among its extensive scope of responsibility, BESS attaches a great deal of importance to equipment reliability. This approach is being driven by the corporate directive NGGD-1610, 'Directive for Zero Tolerance for Equipment Failure'. The directive provides a corporate policy that, aiming at zero equipment failure; preventive maintenance shall be continuously optimized and properly implemented to prevent equipment failure. A key part of this policy is to develop a culture that thinks differently about equipment performance.

In implementing the policy mentioned above, and in accordance with the corporate procedure for equipment reliability, BNP has developed an effective and integrated approach to improve equipment reliability. The integrated approach incorporates;

- Identification of priority items that have operational impact and require resolution
- Development of detailed action plan
- Weekly review of open items at the equipment reliability priority meeting
- Quarterly review of equipment reliability items identified in CAP.

BNP has improved the focus on root cause analysis and thorough resolution of problems. The plant focus on implementing actions to resolve equipment reliability challenges resulted in the completion of 15 equipment reliability items during the last refueling outage.

On the other hand, the team noted several plant issues that could be more quickly resolved. The team suggests increasing focus to more quickly resolve plant issues that have operational impact.

BESS also gives high priority to system monitoring and trending. The purpose of this effort is to monitor system health and communicate system performance. Implementation of system monitoring and trending includes;

- Trending characteristics of a system on regular basis.
- Performing system walkdowns periodically to identify physical conditions that may adversely impact system and component performance.
- Visualizing overall system health through the use of a system health report that summarizes overall system health in the areas of operation, maintenance, regulatory and engineering.
- Holding a weekly forum "System/Program Review" to keep station management informed of the status and performance of plant systems and programs.

Through the activities of system monitoring and trending, any concerns regarding operational safety are highlighted in a comprehensive manner so that appropriate actions can be immediately taken. The current status and performance of systems important to safe and reliable operation are effectively monitored and clearly communicated.

The team, however, observed shortfalls in installation of non-safety related computer systems and low energy cables for communication services that are not specifically being monitored. The team provides a suggestion in this regard.

Another important activity at BESS is to effectively implement engineering programs. Any engineering issues that need comprehensive solution common to each nuclear power station at Progress Energy or continuous update in engineering activities are covered and controlled by engineering programs.

For the purpose of effective and efficient management in implementing engineering programmes, a graded approach is utilized;

- Corporate level: performed by a team consisting of representatives of stations led by a corporate chief
- Station level: performed by a team consisting of representatives of stations
- BNP level: performed by representatives of sections at BNP.

Engineering programmes include: Maintenance rules, Preventive maintenance, In-service inspection, Fire protection, Flow accelerated corrosion, Environmental qualification, Station blackout, Thermal performance, Motor operated valves and Air operated valves.

BNP submitted an application for 'License Renewal' in October 2004 in accordance with 10CFR54, following Robinson Nuclear Power Plant, which submitted the application in 2002 for the first time at Progress Energy. BNP expects an issuance of new license within the year 2006. The current operating license expires on December 27, 2014 for unit 2 and September 8, 2016 for unit 1.

Preparatory work for license renewal application includes Integrated plant assessment, Time limited aging analysis, UFSAR supplement and Environmental report supplement. This extensive technical work was done by a corporate team responsible for the license renewal at all Progress Energy nuclear plants. It deserves to mention that this work was completed with

very limited scope of outsourcing. Most of the work was done by internal resources, which will better position the plant to address future aging management challenges.

The extensive range of engineering activities at BESS as mentioned above requires significant size and sufficient level of resources. BESS has 137 personnel. Approximately 80% of them are college graduate and their averaged nuclear experience is over 20 years.

Training and qualification for the engineering support personnel are implemented in accordance with corporate procedure for 'Engineering Support Personnel Training & Qualification Programme'. Management responsibilities for staff training are clearly defined. Under the corporate procedure more than 100 qualification cards are prepared for each skill and knowledge required to perform engineering activity and utilized for providing training and qualification.

Engineering activities are monitored and evaluated in the self evaluation process. Evaluation is implemented utilizing a set of 34 key performance indicators and its subordinate performance indicators. Plant indicators are updated on a monthly basis.

Due to the wide-ranging scope of responsibility BESS has broad interface with other BNP sections as well as the corporate engineering department (NESD). Brunswick engineering responsibilities are clearly described in the plant operation manual Brunswick Engineering Support Section Conduct of Operations.

Various measures are taken to maintain good communication and cooperation with other sections. The engineering rapid response team works jointly with the 'Fix It Now' (FIN) team to more effectively resolve short-term plant issues. Equipment reliability priority meeting and System/Program review meetings are held every week and play an essential role of ensuring information sharing and cooperation between sections and with senior management. In addition, monthly Plant Nuclear Safety Committee (PNSC) and Project Review Group meetings ensure that important issues receive detailed review by senior managers. For example, the 'License Renewal Application' was reviewed at the PNSC four times before the application to NRC. Similarly, the Extended Power Uprate project is a routine review item for PNSC and the project review group.

BESS has contracts for outsourcing engineering services with Architect Engineer (AE) companies and engineering service companies (e.g. General Electric). Typically three to four architect engineering companies are selected as Preferred AE's and Specialty Engineering Contractors. Companies that are selected as preferred AE's are re-evaluated periodically based on their performance. Outsourcing process is defined by the corporate procedure for outsourcing engineering services.

## **5.2. SURVEILLANCE PROGRAMME**

BNP has established an overall surveillance programme, which is prepared in accordance with technical specification. The surveillance programme includes administrative procedures, individual test procedures and tools for schedule control, acquisition and analysis of data and others.

Surveillance programme are implemented by cooperation of engineering, maintenance and operation section. The engineering section is responsible for maintenance and updating of the surveillance test procedures and acquisition and analysis of data. The operations department is

responsible for operation of plant equipment and schedule control. The maintenance department is responsible for implementation of the tests. Organizational responsibilities are clearly defined in procedures. Related information is posted on their internal net in the various forms and shared by related sections/groups and well utilized.

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The data and parameters acquired are monitored in the form of trends or statistics and analyzed. Changes in the data are evaluated for updating procedure, frequency or acceptance criteria. Any change indicating concern over system/component health is communicated to the personnel implementing the test so early detection of any further change is ensured.

Individual test procedures are written in a comprehensive manner and easy to understand, including purpose, prerequisite, acceptance criteria and procedure steps. Acceptance criteria are clearly shown in the data record form along with desired values. At every critical step in the test, "Caution" and "Note" are highlighted indicating noteworthy items so that personnel implementing the test can pay attention.

Surveillance tests schedule is effectively controlled in terms of long-term schedule (16 week schedule), 3 days schedule and a daily schedule. Those schedules are posted on the station intranet and notification is sent to the related personnel. Any delays of the tests caused by fault in preparation or implementation of the tests were not found.

The Primary Containment Isolation System (PCIS) surveillance test was observed. The I&C team implementing the test demonstrated good performance of actions to prevent human performance errors. They performed pre-job briefing and maintained three way communication and independent verification at every critical step as instructed in the procedure. Jumper cable attachment was done in a professional manner.

The plant regards any test or evolution as special test if such test or evolution is performed less frequently than quarterly and if improper conduct of such test and evolution may result in degrading the plant's margin to safety. Special tests are conducted in accordance with the plant program procedure identification, development, review and conduct of infrequently performed tests or evolutions.

Recent examples are diesel generator function test; plant data gathering during plant startup on systems and equipment that have incorporated modifications for power uprate and so on. Those special tests have been reviewed by Plant Nuclear Safety Committee (PNSC).

Timely return of the tested system to the normal operation is ensured in accordance with test procedure.

### 5.3. OPERATION EXPERIENCE FEEDBACK (OEF) SYSTEM

(See Chapter 6)

#### 5.4. PLANT MODIFICATION SYSTEM

In the plant, all the modifications are controlled and tracked by engineering change system which consists of processes of engineering change request, engineering change and design review. Implementation of each process is defined in the following procedures: Engineering Change Request, Engineering Change, and Design Review Requirements respectively. Modification processes are backed by quality assurance and document control to ensure the reliability of engineering, as defined in the following procedures, Engineering Product Quality, and Maintenance of Design Documents respectively.

These procedures, along with subordinate procedures and guidelines, are well structured and maintained and provide clear and well understood flow path for entire modification processes. It was noted that procedure, Engineering Product Quality, was revised in July 2004 to ensure a higher quality of the engineering work by providing detailed checklists for every activity in the engineering work.

Responsibilities are defined in the related procedures. Brunswick Engineering Support Section (BESS) is responsible for implementing engineering change, design review, quality assurance and maintenance of design documents. Modifications which relate to Updated Final Safety Analysis Report (UFSAR), technical specification or other safety concerns are reviewed by PNSC. Passport is used to administratively track engineering changes. Passport controls are used to ensure that there is no mismatch between responsibility and authorization at each step defined by the related procedures.

Temporary modification requirements are specified and controlled by a corporate procedure for engineering changes. The corporate procedure is augmented by a plant procedure to control installation, tracking, and removal of temporary modifications. Plant manager approval is required to maintain a temporary modification in service beyond a refueling outage.

Currently six (6) temporary modifications are in use and awaiting removal at the next outage. One temporary modification is in progress and no significant impact on the plant safety is observed.

In the year 2004, more than 150 modifications were implemented at the plant. Each of them is documented and controlled by an engineering change package, which includes statement of problem and solution, design specification, drawings, procedure and sketch for installation and test procedure. Modifications were completed within the due date or the tolerated period and no one exceeded the late due date.

It deserves to mention that BNP has implemented Extended Power Uprate on both units and is the only US BWR to achieve the full power uprate (120% of original licensed power level). The project included several modifications to ensure minimizing impacts on safety margin, operation, and integrity of systems and components. This should be noted as a significant strength of the plant management.

As a 30-year old plant, BNP faces an increasing obsolescence challenge, particularly with instrument and control systems. BNP will need to identify and make plans to renew systems and components for which there is no effective way of maintenance other than replacement. A comprehensive long-range replacement plan should be considered for this purpose. The team made a suggestion in this area.

## 5.5. REACTOR ENGINEERING

The core management function is under the responsibility of corporate Nuclear Fuels Management & Safety Analysis and station reactor engineering group. Corporate fuels engineers provide an overall core operating strategy via the Cycle Management Report and assist with the major control rod sequence exchanges to effectively utilize the fuel. Reactor engineers provide recommendations to the licensed operators while direct reactivity changes are directed and executed within operations.

The core management function is clearly defined in site procedure, Reactor Engineering Guidelines. Conduct of shift, surveillance testing, and system monitoring are clearly defined in site procedures. Reactor engineers are familiar with procedures. Procedures which involve aspects of reactivity management are prejob briefed with operations prior to performance to ensure understanding of specific roles and responsibilities as well as critical job steps.

There are six on-shift reactor engineers with experience ranging from 7 to 26 years. Reactor engineers monitor daily reactor operation, conduct testing, direct power changes, and coordinate outage activities to effectively manage the two reactor cores.

Daily monitoring of the core performance parameters is conducted and trended in shift logbooks. The critical safety parameters such as thermal limits, control rod density vs exposure, fuel integrity, etc. are trended and reported to management on a monthly basis. The core performance parameters can also be monitored via two monitors installed in the office of reactor engineering group.

Technical specification required testing is scheduled within the work management system. Results are compared against established acceptance criteria and reported within the electronic operations log. Schedule adherence is monitored and reported by the Outage & Schedules group.

Powerplex is the current core monitoring software which is maintained via corporate procedures Powerplex Data Bank Maintenance and Core Follow Calculations. Heat balance accuracy is verified at least monthly via Core Thermal Power Calculation. Additionally, alternate power indications are used every 10 percent power change during transient recoveries and startups.

Fuel movements required for refueling outages are generated by sophisticated computing tools (shuffleworks) and tracked from receipt to discharge to meet the special nuclear material accounting requirements via computer software. Fuel moves are verified/validated by multiple members of the plant staff. Inventories are verified in accordance with the requirements of the site Special Nuclear Material Accountability Plan that meets all Federal requirements.

Historical fuel failures have been promptly identified within the site corrective action programme. Comprehensive root cause determinations have been performed to fully understand the failure mechanisms and to provide barriers to similar failures. In the past ten years 14 fuel failures were experienced. Among those whose root causes have been determined 78% were caused by debris.

During current and past cycles failed fuel has been effectively managed in accordance with the failed fuel action plan established in the procedure, Fuel Integrity Monitoring. The prompt



actions taken to detect and suppress several fuel leakers in recent cycles have maximized power generation without increasing leaks.

## 5.6. FUEL HANDLING

Fuel receipt inspection is performed in accordance with site procedure New Fuel, Channels, and Channel Fasteners Inspection. The procedure delineates inspector training and visual acuity requirements and the inspection criteria in accordance with vendor recommendations.

Fuel movement sequences are prescribed as defined in site procedure Preparation of Core Component Sequence Sheets. The written sequence is independently verified by a qualified member of the reactor engineering staff. The sequence of moves is then approved by a licensed senior reactor operator. The in-progress fuel movements are concurrently verified by a fuel handler, spotter, and senior reactor operator.

Foreign Material Exclusion Programme ensures the responsibilities for the control of foreign material are understood within the organization. The utility has worked with the fuel vendor to understand the causes of fuel failures through inspection efforts and to establish barriers to the introduction of foreign material into plant systems and the fuel bundles.

Heavy load movement is conducted via established pathways as defined in site procedure "Operation and Inspection of Cranes and Material Handling Equipment".

Fuel storage areas are clearly defined and delineated to meet strict criteria. Fire suppression devices are modified to ensure the plant can combat fire in the area without creating an environment susceptible to an inadvertent criticality event. Specifically, the new fuel vault drain is plugged and a smooth bore nozzle replaces the fogging nozzle at the fire station adjacent to the fuel storage vault.

Fuel criticality and worker exposure monitoring is performed during new fuel and irradiated fuel handling operations as prescribed in the following procedures; Refueling, Refueling Platform Operations, and in the procedure for Health Physics Coverage in the Drywells During Fuel and Irradiated Component Movement. One-Rod-Out Interlock jumper and removal, that is required when multiple control rods withdrawal is performed for their maintenance purpose, are strictly controlled by the station procedure.

Fuel movement records are maintained for the life of the plant. Electronic databases are maintained to quickly retrieve special nuclear material location histories. Annual audits are performed to verify special nuclear material locations.

Storage of irradiated fuel is described and controlled by UFSAR Section 9.1.2. There are no restrictions on placing any BWR fuel bundles in any BWR storage rack in either Unit 1 or Unit 2 spent fuel pools. The integrity of the spent fuel pools has been reviewed. The plant has performed analysis of the systems, structures, and components integrity and the plant found that the integrity of spent fuel pools is acceptable and within operating limits. Supplemental fuel pool cooling is used during refueling outages to facilitate the additional heat load. Spent fuel pool cooling is described in the UFSAR Sections 9.1.2 & 9.1.3.

Accurate accounting of fuel is required by the Special Nuclear Material (SNM) Accountability Plan. The SNM database is updated to reflect fuel movements as they are completed.

Component record cards are created and updated to track fuel movement and are maintained for the life of the plant.

#### **5.7. COMPUTER APPLICATIONS IMPORTANT TO SAFETY**

In the plant, computers are used for operation, core monitoring and management, information system, business management and training. Definition of safety related computer application is provided in procedure Software Quality Assurance and Configuration Control of Business Computer Systems.

Computers providing any controls to the plant operation (e.g. feed water pump turbine speed control system) are under the responsibility of the engineering section. All other computers used in the station including those computers providing plant essential parameters and information are under the responsibility of the nuclear IT department.

Controls for monitoring and modifying computer applications are defined in the procedure for Software Documentation and Testing, and Software Quality Assurance and Configuration Control of Plant Digital System.

Quality assurance system is established for computer applications as defined in the procedure for Software Quality Assurance and Configuration Control of Business Computer Systems. Four (4) categories (A, B, C and D) for computer quality level are defined and detailed quality assurance requirements for each quality level is specified. The plant process computer (PPC) is classified as level B and all other computers are classified level C or below.

The plant uses several computer modules for nuclear safety functions: Power Range Neutron Monitoring System, Suppression Pool Temperature Monitoring System, HPCI/RCIC Speed Control System. The software of these computer modules have been verified, validated and loaded before shipped under the responsibility of vendors and are not accessible at the plant.

Any failures of computers are being tracked and evaluated in accordance with CAP programme as defined in the procedure for Corrective Action Programme. BNP experienced an eleven hours failure of plant process computer (PPC) due to a power supply problem on August 17, 2004. Monitoring of the plant heat balance and reactor core status was maintained successfully by alternative actions taken by operators in accordance within station guidelines.

PPC provides plant parameters and information to the station business computers via fire walls. Plant parameters and its trends are available by the station intra network at any personal computer at the plant on nearly real-time base, to the satisfaction of employees at the plant.

PPC has duplicated structure for the fault tolerance purpose. The plant possesses one full set of PPC components as spare parts. Modification for PPC and other computers is controlled in accordance with procedure for Software Quality Assurance and Configuration Control of Plant Digital System.

## DETAILED TECHNICAL SUPPORT FINDINGS

### 5.1. ORGANIZATION AND FUNCTIONS

**5.1(1) Issue:** BNP has a powerful engineering force capable of preventing and resolving problems. However, some items noted indicate that improvement can be made in more timely resolution of some identified plant issues.

- An intermittent annunciator alarm associated with the augmented off gas system has been a problem for over six months and is not yet resolved.
- Spurious trips of the hydrogen eater chemistry system have been occurring for more than four years and have not been resolved.
- Several failures of electric components have occurred in recent years resulting in LCO conditions.

Without increased focus of engineering activities on identification and resolution of plant issues, significant reduction in plant issues will not be effectively achieved.

**Suggestion:** BNP should increase focus to more quickly resolve plant issues that have potential operational impact.

**Basis:** IAEA Safety Standard NS-R-2, 2.3(3).

**5.1(2) Issue:** The installation of non-safety related computer systems and low energy cables associated with non-intrusive plant communication services has some shortfalls.

The plant process computer (PPC) modules are mounted in the chassis in the EOF. The chassis is anchored to the ceiling but the anchors are loose and chassis are wobbly. Some of PPC modules are placed on the tray without being fixed

Several telephone, communication and monitoring system cables that are not required for plant operation were observed in various locations of the plant and are not firmly fixed to the wall or other structure

Without proper installation, even a small external hazard would cause failure of such computer systems and communication services, resulting in impediment to plant operation.

**Suggestion:** BNP should consider improving installation of non-safety related computer systems and low energy cables associated with non-intrusive plant communication services.

**Basis:** IAEA Safety Guide NS-G-1.1; Software for Computer Based Systems Important to Safety in NPPs, para 12.1-12.16.

### 5.4. PLANT MODIFICATION SYSTEM

**5.4(1) Issue:** BNP is developing an asset management program and has a draft procedure in review (System Strategic Plans). However, there is no comprehensive long-range replacement plan at the plant level to ensure smooth and strategic renewal of systems and components for which there is no effective way of maintenance other than replacement.

- BNP faces an increasing obsolescence challenge, particularly instrument and control systems
- Personnel development plans have not been established to support design and maintenance of new technologies such as digital controls

Without a comprehensive long-range replacement plan BNP will meet difficulty in implementing renewal of systems and components when replacements are needed.

**Suggestion:** BNP should consider establishing a comprehensive long-range replacement plan at the plant level to ensure smooth and strategic renewal of systems and components for which there is no effective way of maintenance other than replacement.

**Basis:** IAEA Safety Standard NS-G-2.3 para 4.8.

**5.4(a) Good practice:** BNP has effectively managed the effect of Extended Power Uprate (EPU) and is the only US BWR to achieve the full power uprate (120% of original licensed power level). The EPU project included several modifications to ensure that operational impacts are minimized, redundancy is maintained in key BOP equipment, and transient/accident performance of some key equipment is improved over the original design.

- Fuel design to a 10x10 design provides 6-12 percent additional thermal margin, and installation of power range neutron monitoring instrumentation provides improved operational flexibility.
- The condensate system is being modified to maintain spare condensate and condensate booster pumps such that overall system reliability is not reduced.
- The feedwater pumps are being modified to significantly improve the capacity and establish scram margin in the event of a single pump trip. This scram margin for a single feedwater pump trip event was not available prior to EPU.
- The SLC system was modified to use enriched boron solution which will meet aAnticipated Transient Without Scram requirements with only one pump. Prior to power uprate, two SLC pumps were required. This has established redundancy in the SLC system and resulted in an overall reduction in Core Damage Frequency (CDF) and Large Early Release Frequency (LERF) as a result of EPU.

## **6. OPERATING EXPERIENCE**

### **6.1. MANAGEMENT, ORGANIZATION AND FUNCTIONS OF THE OE PROGRAM**

Brunswick Nuclear Plant (BNP) utilizes Nuclear Generation Group (NGG) common approach to conduct Operating Experience Feedback management based to INPO standards. NGG directive –1400 NGG Self Evaluation Program establishes clearly the self-evaluation policy. BNP self-evaluation programme covers all areas of the operating experience feedback process. Self-evaluation programme is composed of four cornerstones: the corrective action program, operating experience, self-assessment and benchmarking programs.

The use of OE is part of the safety culture. Monthly self-evaluation meetings are held in each department. Managers review the nuclear condition reports and observation reports of the last month, new adverse conditions reports may be raised to counter adverse trends. Eventually they evaluate department's performance indicators including self-evaluation program.

Requirements for Nuclear Conditions Reports (NCR) are well described in the corrective action programme. There are three NCR priorities.

- NCR priority 1, called Significant Adverse condition. A significant adverse condition investigation is performed for significant event that have major consequence on plant operations.
- NCR priority 2, called Adverse Conditions where a cause determination is required to correct the cause.
- NCR priority 5, called Improvement/Suggestion

In July 2005 a new passport version will be implemented. A new category of NCR will be created for low-level events that need correcting, tracking and trending. However, the team noticed that currently low-events are reported at the second level just below the significant adverse condition as adverse condition. The team suggested improvements in the efficiency of event analyses.

Duties, responsibilities and lines of communication are clearly implemented as defined through CAP-NGGC procedures: "Corrective Action Programme, Self Assessment, Operating Experience Programme, Benchmarking, Significant Adverse Condition Investigations, Corrective Action Programme Trending and Analysis". The self-evaluation group provides assistance to different departments for root cause analyses.

Highly visible self-evaluation indicators for site and departments are monthly established and used to improve site performance.

### **6.2. REPORTING OF OPERATING EXPERIENCE**

All BNP personnel initiate nuclear condition reports using 'Action Tracking Co-Pilot'. Supervisors validate the nuclear condition reports (NCR) information. In each department a unit evaluator reviews the NCR information for completeness. Senior managers weekly review the NCR's initiated in the leadership meeting on Monday and Thursday.

NCR identification and reporting is encouraged and reinforced at all levels in the organization. The 'Passport' action tracking is the plant database related to events. In 2004 the site initiated 81 significant adverse condition reports and 2580 adverse condition reports.

All NCR are reported in timely manner. The team did not find any adverse condition to be reported that was not captured into the database.

Observations database is used to capture positive and negative observations reports during plant tours. 1390 observations were reported during the fourth quarter 2004.

During refuelling outages a specific team (BOOST) adds field observations and reviews data daily for trends. Observation data is used to develop daily safety and human performance tips.

### 6.3. SOURCES OF OPERATING EXPERIENCE

Institute of Nuclear Power Operations (INPO) and Nuclear Regulatory Commission (NRC) sources are screened on a daily basis to early learn from events occurred at United States plants. All INPO data of BNP are formally used to disseminate throughout the management the comparison to nuclear industry average (best quartile, medium and worst).

The Operating Experience Programme at NGG sites demands to raise an OPEX Action request (Passport Action Tracking system) for all inclusion required OE items such as Significant OE Report (SOER), Significant Event Report (SER), Significant-By-Others (SO), Significant Event Notification (SEN). By doing this way, BNP uses all the main sources of nuclear industry information.

The OE coordinator ensures interface with the corporate organisation through a weekly meeting, as well with other Progress Energy nuclear plants. Within each department, a unit evaluator drives operating experience and self-evaluation.

Benchmark trips are frequently carried out to get best industry practices as source of improvement.

Adverse condition reports are initiated for BNP indicators that do not meet the target. For example key performance indicator, capacity factor had not made its 2004-year end target for both units and an adverse condition report was generated. It shows the strong focus of management to achieve the goal.

### 6.4. SCREENING OF OPERATING EXPERIENCE INFORMATION

Operating experience information is appropriately screened, to select and prioritize the information for further investigation. The CAP-NGGC procedure, operating experience programme provides a guideline for screening in-house and industry events. The OE coordinator is responsible for the day to day screening in-house events to determine those relevant to the nuclear industry. In-house significant and worthwhile events are transmitted to INPO within an average 46-day time. The timeliness of screening is considered satisfactory. The results of the screening include the following: root cause or apparent cause, contributors, corrective actions, consequences, safety significance and generic implication. If sending nuclear industry information needed promptly, then BNP would submit a preliminary event report to INPO.

## 6.5. ANALYSIS

CAP-NGGC procedure, Corrective Action Programme clearly defines criteria for performing analysis:

- For significant adverse condition a thorough analysis is performed to prevent the recurrence. In this case a root cause analysis is performed. The root cause analysis includes a search of similar events from internal and external sources.
- For adverse conditions an apparent cause determination is required to correct the cause,

Since the beginning of 2005, 8 out of 30 priority 1 nuclear condition reports are due to management discretion that decided a root cause analysis should be conducted. This shows management involvement to prevent recurrence of events. Analyses are performed in accordance to their due date required in Corrective Action Program. The timeliness standards are:

- Significant adverse condition investigation 21 days
- Adverse conditions investigations 30 days

All investigations are carried out in a timely manner. The average age of significant adverse investigations is 19 days within age target of 21 days. The average age of adverse investigations is 29 days within age target of 30 days.

Personnel called "root cause investigators" are qualified during a three-day training course to perform analyses. Currently there are 129 qualified root causes investigators. A specific package is used to refresh the knowledge of personnel assigned to perform root cause investigation.

Low level events are captured as adverse condition priority 2 and observation reports as well. Only low level events classified as adverse condition have cause codes assigned.

BNP has defined specific criteria for human performance errors: The highest level is called a site level human performance event. Criteria for human performance events are not aligned with significant adverse condition defined in Corrective Action Program. BNP is encouraged to maintain performing root cause analysis for HP events.

## 6.6. CORRECTIVE ACTIONS

The corrective action programme is very strong and closely monitored. Corrective actions are prioritised, scheduled for implementation. Dates for actions are commensurate with the importance of the item, BNP priorities, and the consideration of preventing the recurrence. All evidences and documents are attached to all completed actions.

The timeliness standards for corrective action are:

- Corrective actions to prevent from recurrence have to be completed within 90 days.
- Other corrective actions have to be completed within 120 days.

An effectiveness review is performed on each significant adverse condition report to evaluate how well corrective actions prevent from recurrence. If the reviewer identified insufficiency, a new adverse condition would be initiated. Quality reviews are performed upon the completion of the analyses by the self-evaluation team. Quality of investigation for priority 1 and 2 are weighted at 60% and the other 40% measures timeliness standards in the CAP

program health indicator. The team recognized 'Corrective Action Programme' monitoring as a good practice.

Targets to implement corrective actions are met for all nuclear condition reports. There is no overdue action for nuclear condition reports priority 1 and 2. The number of extension approvals to exceed the initial due date is very low compared to the total number of corrective actions. However, the specific target to implement actions of external operating experience is not met at the current time.

#### 6.7. USE OF OPERATING EXPERIENCE

Operating experience information is widely used throughout the station in personnel work and training activities. BNP personnel are aware of management expectations to use OE information.

Operations are responsible to enter OE information into pre-job database. This tool is easily accessible to BNP personnel. Internal and external OE information relevant to a task is put in this tool. This tool is useful to prepare pre-job briefings for repetitive task. Maintenance planners prepare work order packages including the more relevant OE reports from INPO. Workers have opportunities to provide feedback on work packages in post-job briefing critiques and informal meetings.

Operating experience is extensively used in the training materials for station personnel. Mechanical cycle training includes a large piece of OE feedback, INPO just in time, in-house events, SOER and SER. There are three, four day training cycles every year. Maintenance managers use OE to kick off cycle training course. Maintenance management periodically issues newsletters including a list of OE reports.

In operations, shift managers used NRC web site and Brunswick reports to provide to the staff information about external and in house event within shift turnover.

BNP is focusing on Human Performance (HP) improvement. A human performance steering committee ensure implementation of Human Performances principles throughout the teams. There is a human performance forum providing HP policy, procedures, reports, tips and hints, and error tracking indicators.

All BNP events have a cause code assigned including those due to human performance. Using this data, an adverse trend was identified in work practices across the site during the first quarter of 2004. To improve this, BNP has been focusing on the promotion of six human performance tools and improvements within each team. Last year INPO provided pieces of advice to supervisors and senior management. Maintenance is focusing on human performance improvement by providing a strategic plan, cycle training, behaviours expectations and work practices improvements learned by benchmarking.

Since October 1 2004, the plant has set a human performance error tracking indicator called "Error Free Day" to highlight human performance results to the site. The plant has defined the criteria that trigger a reset of this indicator. When an event resets "error free day" a straight talk provides information to staff with lessons learned.

Before outages contractors received two-hour time human performance training. BNP is implementing training session called 'Human Performance Refresher' using HP tools for engineers, from INPO issued in March 2005.



Every day all BNP personnel can watch a new 'HP tip' to bear in mind management expectation. Good behaviours are rewarded. The team encouraged analysing and registering good human performances to emphasize HP improvements. The recovering acts could also be captured to demonstrate how personnel attitudes act as a defense line against adverse conditions. This may even better motivate BNP personnel and help them to learn more from good performance observed at BNP. The human performance approach was considered as a good performance by the team.

#### **6.8. DATABASE AND TRENDING OF OPERATING EXPERIENCE**

Data bases related to nuclear condition reports and observation reports are used to analyse operating experience from the point of view of organizational, human performance, equipment failures, work management, and maintenance deviation reports.

On a quarterly basis the self evaluation unit performs a data evaluation report to identify adverse trends. This report provides to management an integral overview of data and trending at BNP. Currently nine adverse trends are open: fuels defects, equipment reliability, general site human performance, minor NRC violations, plant leak management, emergency preparedness selective signalling, maintenance human performance, maintenance procedure adherence, and quality of engineering modifications. Number of significant adverse condition reports is increasing over the three past years. The cause is not available. Condition report (CR) data distribution shows only 11% of conditions reports are related to operations focus. The plant envisages comparing to others plants if data are available.

Observations reports are analyzed by the unit evaluator within each department and put into "buckets" to be trended for monthly roll up meeting. Each department uses its own code causes called "buckets" to trend observation reports and nuclear condition reports. If an adverse trend is identified, then an adverse trend CR would be initiated.

The team encourages BNP to compare frequencies of cause for low event/adverse conditions/significant adverse conditions to analyze the efficiency of the line of defense as soon as an additional tier is available. As a matter of fact root causes of the event can be considered as line of defense breakdown. This allows measuring the efficiency of each line of defense. For example observations and investigations could be focused on the weak lines of defense that had caused significant adverse and adverse conditions.

#### **6.9. ASSESSMENT AND INDICATORS OF OPERATING EXPERIENCE**

The 'Self Assessment Programme' is very strong. Every two years the self-evaluation team carries out a mandatory self-assessment on OE areas such as corrective action programme, SOER and operating experience implementation.

Benchmarks are planned to get good practices in areas previously identified by management as needing improvement items. The way to carry out a benchmark is defined in a procedure. 19 benchmarks were performed in 2004 and 26 are planned for 2005.

For example, a formal benchmark had been performed to address an issue identifying a failure of maintenance personnel to adhere to work and procedure during unit 1 outage in 2004. This issue was raised by NAS assessment. The process to treat NAS issue is very rigorous.

Indicators are used to track the effectiveness of self-evaluation programme health. Examples of these indicators are: Corrective action programme health, Benchmark health, Operating experience programme health, Self-assessment programme health. These indicators are widely used at BNP and provide a straight view of health of each programme. Self-evaluation programme indicators were considered as a good practice by the team.

## DETAILED OPERATING EXPERIENCE FINDINGS

### 6.1. MANAGEMENT, ORGANIZATION, AND FUNCTIONS OF THE PROGRAMME

**6.1(1) Issue:** The plant utilizes a correction action program with two classifications. The use of two classifications may not allow sufficient differentiation for an efficient analysis and trending. The team observed the following facts during the review:

- The present graded system of reporting all events includes two levels: Significant adverse condition and adverse condition.
- Low level events are reported at the second level just below the significant adverse condition as adverse condition (nuclear condition report priority 2) for example: at home, while pulling on a sweater the badge came loose or poor housekeeping at the media center. This level also includes events that are higher safety related as for example: NCR 138757 to report adverse trends of 10 minor violations of Nuclear Regulator Commissioning requirements.
- Low level events are captured as adverse condition priority 2 and observation reports as well. Only low-events classified as adverse conditions have cause codes assigned.

Without a graded system based on enough tiers, the plant is losing opportunities to focus analyses and resources in accordance with the significance of the events.

**Suggestion:** Consideration should be given to more efficiently analyze events by following through on the plan to refine the grading systems and tiers.

**Basis:** IAEA Safety Standards NS-R-2 para. 2.24, NS-G-2.4 para.6.64 and 6.68.

### 6.6. CORRECTIVE ACTIONS

#### 6.6(1) Good practice: Corrective Action Program (CAP) Monitoring

The methods used in the Brunswick Operating Experience area to monitor the quality of Corrective Action Program (CAP) activities are unique and effective. Significant adverse condition investigations and root cause analyses are critically reviewed and given a score based on quality of the analysis by the Self Evaluation Unit. Specific criteria are evaluated using a quality review sheet. Also, 100% of the completed significant adverse condition investigations are reviewed for quality. All Self Evaluation Unit staff members participate in this quality review which enhances the process since the staff has the benefit of various backgrounds and experiences (operations, maintenance, environmental/chemistry and training). Feedback on the quality of these investigations is provided to the approving supervisor and investigator.

The scores of these quality review sheets are an element of the CAP Programme Strength Key Performance Indicator (KPI). The KPI is weighted with an emphasis on quality (60%). The other 40% measures timeliness standards. The timeliness standards are:

- Significant Adverse Condition Investigation 21 days

- Adverse Condition Investigation 30 days
- Corrective Action to Prevent Recurrence (CAPR) 90 days
- Corrective Action (CORR) 120 days

Quality and timeliness goals are established for the completion of Significant Adverse Condition Investigations, Adverse Condition Investigations, Corrective Actions to Prevent Recurrence, and Corrective Actions.

Formal effectiveness reviews are conducted after corrective actions have been completed to determine the effectiveness of the corrective action plan.

CAP Program Health Indicators are used by the Brunswick Nuclear Plant (BNP) management team to improve CAP activities. Timeliness standards are reviewed weekly at the BNP Leadership meeting and actions are taken to focus on the completion of investigations and corrective actions. This indicator is reviewed by the Brunswick Self Evaluation Team at their routine meetings. The CAP Program Health Indicator is updated monthly and included in the KPI report generated by the Director of Site Operations and provided to the Nuclear Generation Chief Nuclear Officer and Senior Vice President. These measures have focused attention on the quality and timeliness of the corrective actions leading to better performance in this area.

## 6.7. ASSESSMENT AND INDICATORS OF OPERATING EXPERIENCE

### 6.7(1) Good practice: Self Evaluation Program Indicators

'Self Evaluation Program Health Indicators' are used by the Brunswick Nuclear Plant (BNP) management team to improve activities in the areas of corrective action program (CAP), self assessment, benchmarking, and operating experience. These indicators are weighted with an emphasis on quality (60%). The other 40% measures timeliness standards. The results display green as on target, yellow as in jeopardy and red as off target with monthly performance trend (improving, stable, degrading). The health indicators are updated monthly and reviewed at the department, site and Nuclear Generation Group level. For example, CAP timeliness standards are reviewed weekly at the BNP leadership meeting and actions are taken to focus on the completion of investigations and corrective actions. This indicator, along with the other self evaluation programme KPIs, is reviewed by the Brunswick self evaluation team at their routine meetings. The 'Self Evaluation Program Health Indicators' are updated monthly and included in the KPI report generated by the Director of Site Operations and provided to the Nuclear Generation Chief Nuclear Officer and Senior Vice President. These measures have focused attention on the quality and timeliness of actions leading to better performance in this area.

## **7. RADIATION PROTECTION**

### **7.1. ORGANIZATION AND FUNCTIONS**

The radiation protection unit at Brunswick Nuclear Plant is part of the environmental and radiation protection section. The section consists of 3 units which closely cooperate: the chemistry unit, radiation protection (RP) unit and E&RC programs (ALARA, RADWASTE shipping, dosimetry, and instrumentation).

Administrative limits, policies and appropriate goals, objectives and performance indicators are set by procedures. The annual administrative exposure limit (AL) per year is 2 Rem (20 mSv) per individual. Basic limits are set by NRC regulation. At the 0700 daily meeting of the RP teams and staff, safety, human performance, plant status, ALARA, condition reports, operational focus list, and RP work activities are discussed.

The organizational structure is well defined and staffing within the E&RC dept. is sufficient. Comprehensive procedures at the site and within the Progress Energy Nuclear Generation Group (NGG) describe the activities within the radiation protection process. Responsibility of RP personnel is described by job descriptions, which is part of the Human Resources Job Description.

There is a set of performance indicators (PI) that are used to measure effectiveness of the RP program. There are 10 performance indicators related to radiation protection and 38 performance indicators related to chemistry. The indicators include occupational exposure, personnel contaminations, and gaseous and liquid effluents. These PIs are evaluated monthly by the Environmental and Radiation Control Manager. Some of the performance indicators are site specific and may not be comparable to indicators used at another utility. Although the performance indicator results are based on measurable data, one of the indicators (radworker knowledge) is very subjective, yet this indicator is measurable by scripted questions.

The target value of 235 Rem for the INPO collective radiation exposure performance indicator for the year 2005 was exceeded in May. The personnel contamination occurrence (PCO) indicator goal is 150 for the year 2005, even though the actual value for last year was 94 and for the year 2003, 67 contaminations. The indicator description for what is counted as a PCO was changed in at the end of 2004 to address changes in the scrub policy. The increase in the site dose is being investigated, but is partially attributed to emergent work and some increase in the radiation levels on the reactor coolant system piping within the drywell during a refuel outage.

ALARA principles are clearly defined and described in relevant procedures and are properly implemented. All planned high dose working activities are regularly evaluated in advance by qualified and competent RP personnel. Task description, status, location of the activity, crew type, man-hours and work description are taken into account as a part of this evaluation.

A radiological pre job briefing is required if the radiological briefing criteria described in the procedure for Radiological Pre-job briefings are met. Post job briefings are held to identify improvement opportunities which are implemented the next time the work is performed. A standardized checklist is utilized to perform the post job brief which ensures consistency in performing the reviews.

Budget and resources for the RP area is adequate. Although radiation protection equipment works well, some upgrade of equipment may be necessary in the future.

The RP group performs self-assessments and benchmarking activities to improve overall performance. Also, the RP organization is routinely assessed by the on-site nuclear assessment section, INPO/WANO, and NRC.

The RP department has developed numerous indicators for tracking and assessing performance. These indicators primarily address issues associated with their compliance with regulatory requirements and company targets. They provide management with insights sufficient to identify and correct performance deficiencies.

Brunswick NPP has a modern and well equipped training facility. There is a flow loop mock-up of a radiation controlled area which is used for team training with maintenance to work on various types of equipment. Also, there is a replica of the RCA access area including operable radiation protection instrumentation. Special training using mock-ups is part of the general employee training program. The RP technician continuing training is performed throughout the year.

The site utilizes low dose waiting areas within the RCA where workers can rest or prepare for further activities while staying out of high radiation fields. This area could be further equipped with safety posters or performance indicators panels. Special low dose waiting areas equipped with air conditioning are located on the refueling floor. The team recognizes this measure as a good practice for workers wearing personnel protective equipment and clothing to protect them against heat stress. Also, there are designated Drinking Areas within the RCA where workers can drink after performing personnel contamination monitoring. Company and station radiation policy doesn't require washing of hands before leaving RCA and contamination area.

## 7.2. RADIATION WORK CONTROL

Radiological work is planned, evaluated and weekly exposure goals are provided to site personnel prior to the week the work is performed. The actual exposure for performing the tasks is compared to dose estimates. Prior to an activity exceeding its exposure goal, corrective actions are taken to minimize the total estimated exposure. Each NPP department has determined its annual, monthly and weekly dose budget. NPP intends to produce a daily dose estimate and evaluation. Special attention is paid to "higher radiation risk activities" such as drywell equipment inspection and maintenance, turbine maintenance and activities related to spent fuel.

The radiation work permit (RWP) program at Brunswick NPP is recognized by the team as a good practice. RWPs are prepared using the PASSPORT application which is technically and organizationally well organized. Everyone who enters the radiation control area (RCA) must register in the PASSPORT system as a part of acknowledging the information in the RWP and activating their Electronic Personal Dosimeter. Both of these actions are required prior to entering the RCA.

There are three possible access points for personnel to enter the RCA at the Brunswick NPP but they are not uniformly equipped. The main entrance and exit to the Radiologically Controlled Area is located in the Service building. Personnel contamination monitors (PCMs) here are appropriately located and monitored to screen personnel at the egress from the radiologically controlled area. However, there is sufficient equipment for hand washing there

are 2 showers which serve only for decontamination and are located at the main access point to the RCA. Workers exiting the RCA including those using protective clothing in contamination radiation area don't use showers prior to exiting the RCA. The same situation is in the case of radiochemistry personnel leaving laboratories to their offices outside of the RCA.

The second access point is located in the same building in the chemistry laboratories and compared to the main control access point there is no personnel gamma contamination measurement, only beta measurement is done at the chemistry exit. The exit serves as a "byway" between radiochemistry laboratories and offices for chemistry personnel. The third potential exit from the RCA is through the material release point at the hot shop. There is a radiological rope and posting that serves as an active physical protective barrier at the access to the RCA through the hot shop.

The physical layout and/or technical equipment of the other two RCA access and egress points need to be reevaluated. For example, the team believes there is insufficient control of the access to the hot machine shop. The exit is not locked and is only protected by a warning sign on a rope. As a result entry is possible without appropriate permission and knowledge of the RP technicians.

The team made a suggestion that the station review the present layout of the RCA, contamination areas and radioactive material areas outside the RCA to improve radiation control and eliminate the potential spread of contamination.

Personnel were observed inconsistently removing their protective clothing when exiting a contaminated area. Also, based on the number of personnel contaminations in clean areas of the RCA, a precautionary practice would be to monitor tools used in clean areas for contamination.

There are only two access points for personnel to RCA. Main RCA access point is located in service building; the second access point is through material release point at hot shops. Not both entry points at the boundary of the RCA have adequate physical layout in order to ensure radiation protection requirements. There are no physical protective barriers at the access to the RCA through hot shops when the doors are open. Exit is not locked and is protected only by warning table on the rope. The barrier can be transgressed in the case of wrong working practices without knowing RP technicians.

Some observed radiation control practices may not provide sufficient protection against the spread of radioactive contamination and the plant should review measures to prevent the potential spread of contamination within the RCA and make necessary changes. The team provided a recommendation to prevent the potential spread of contamination and make necessary changes.

Within the RCA there are contaminated areas where radiation workers have to use personal protective clothing. However, clothing change areas and surface contamination monitors are not located adjacent to contamination areas.

If the change areas and surface contamination monitors are not an integral part of the physical barrier of the contamination area, this may increase the probability of spreading contamination to clean areas of the RCA. The team observed that there is no requirement to monitor tools used in the clean areas of the RCA to identify the presence of loose surface contamination before returning them to the hot tool room.

### 7.3. RADIATION DOSE CONTROL

All radiological work is controlled by radiation work permits. Radiation work permits are prepared and issued by individuals who were appropriately trained. From a review of selected radiation work permits, the team determined that they are written clearly and provide workers with the radiological information and controls necessary to safely perform their tasks. Electronic personal dosimeters are used in the plant and the alarm dose settings are appropriate for the radiological conditions.

ALARA principles are reinforced by the top level of station management with the expectation that individual working groups implement the programme effectively. ALARA job planning is done very well although this is inconsistent with the station exceeding the established dose goal for the year. The station radiation protection group is involved in developing the yearly, monthly and weekly planned dose budget. When planned dose budgets may be exceeded the ALARA team determines if there is appropriate justification and may intervene to help minimize any unnecessary exposure on the job.

The team noted that the housekeeping in the RCA and contamination areas does not correspond with the effort which is given to the implementation of the ALARA principles. Numerous leaks of liquid media, dirt, debris and dust were observed on the floor. This can cause the spread of contamination. An example is the Unit 2 Refueling Floor. The following problems were noted:

- activities related to spent fuel loading to transport cask – dirt, debris and dust on the floor of spent fuel cask storage area,
- material (cables, working tools, plastic bags and plastic foils) stored on the floor within the contamination area,
- several water leaks on the floor.

Tools used in the clean areas of the RCA are not routinely monitored to identify the presence of potential loose surface contamination before returning them to the 'Hot Tool Room'. However, loose contamination on the surface of tools is checked by randomly taken smears which might result in some loose contamination being missed.

The TLD is used as a primary dosimetry, and the EPD (electronic personal dosimeter) as the secondary one. TLDs are evaluated through a corporate laboratory (Corporate Dosimetry, Harris Energy & Environmental Center (HE&EC)) every 3 months. EPDs are used as operative and the results are used for determining the collective radiation exposure (CRE) performance indicator.

An internal exposure evaluation is regularly done. Whole body counting (WBC) using a fast body scan equipment to check quantity of important radioisotopes in the body. When further investigation is required in the cases following an incident where an intake of radioactive material could have occurred.

Every radiation contractor worker has a WBC before starting work in the RCA of the NPP and after finishing it. In vitro measurements are based on plant supervision requirements or recommendation of HE&EC.

Whole body counting and bioassay techniques are used in conjunction with an estimated intake time and standard retention model for inhalation to derive a committed effective dose equivalent. Programme for accessing of internal doses resulting from the content of



radionuclide is utilized. The total committed effective dose equivalent is compared to the NRC annual limits.

Designated plant and contractor supervisors regularly receive reports of their employees' accumulated exposures for use in RWP job planning and scheduling.

#### **7.4. RADIATION PROTECTION INSTRUMENTATION, PROTECTIVE CLOTHING, AND FACILITIES**

The type and quantity of radiological equipment, protective clothing, facilities and equipment both for normal and emergency situations are adequate. Radiological instrumentation is calibrated according to a calibration plan and regularly maintained.

The team recognized as a good practice that Brunswick NPP uniquely utilizes a number of hardware applications to minimize radiation dose for workers. In most cases, the equipment itself is standard and found at most nuclear facilities. What is unique at Brunswick is the way the equipment is used so that it is easily available and effectively utilized.

Calibration of portable radiological instruments is performed by the corporate laboratory. Portable instruments check of calibration and source response before starting of the measurement are performed daily. Calibration of radiation instrumentation located and fixed in the technological parts of NPP is performed by the RP section staff. The calibration facility is equipped with several large gamma and neutron sources and numerous other radioactive sources necessary for calibration.

The calibration of APTEC Personnel Contamination Monitors (PCMs) may not be performed with a source that is representative of the radioactive contamination in the plant. In the calibration procedure is not prescribed what calibration source has to be used, but it is mentioned that alarm setting was based on Cobalt 60. The station performed calibration of APTEC PCMs with Technetium 99 at present that has a low beta energy, while the predominant beta energy at the station is Cobalt 60 that has a higher beta energy. Utilization of Technetium 99 is based on the results of a 2001 analysis of radioisotopes distribution at the plant. Monthly check/response of APTEC Personnel Contamination Monitors does not correspond to the good international practice.

Using a calibration radiation source for instrumentation calibrations with a different energy level than the primary energy level found at the station could cause an instrumentation to respond incorrectly. The team made a suggestion to enhance the calibration of the personnel contamination monitors located at the radiologically controlled area exit.

The gaseous and liquid effluent monitoring instrumentation used at the Brunswick NPP is effective and is being appropriately installed and functional. The responsibility for the use of the instrumentation is shared primarily between the RP and the Chemistry departments. However, the team suggests that the plant will reassess effluent radiological monitoring to determine the need to account for the presence of carbon 14. Also, the computing code used for the assessment of calculated committed doses (resulting from gaseous releases) for critical member of inhabitants and comparison with regulatory dose limits is not independently verified.

The team states that the location of the environmental monitoring air sampling devices needs to be reassessed because one of them was observed to be located under trees and monitoring can be influenced by the absorption of the leaves.

The plant has sufficient inventory of protective clothing for the work activities in the radiation controlled areas and contamination radiation areas. Workers have access to protective clothes and equipment during normal operation as well as during outages.

#### **7.5. RADIOACTIVE WASTE, MANAGEMENT AND DISCHARGES**

The radioactive waste processing system is designed to collect, process, store and prepare for offsite shipment and disposal of plant radioactive wastes. Activity releases are made only after proper sampling, analysis, and monitoring to assure that predetermined release indicators are not exceeded.

The Brunswick 'Waste Management Programme' has been established to control the generation, handling, processing, packaging, and shipment of all waste in order to ensure the regulatory compliance for the handling, processing, packaging, and disposal of radioactive waste and clean trash. Responsibility for implementing is described in this program.

However, the team recommends to reevaluate the classification of the clean trash monitoring facility where sorting of potentially contaminated trash collected from within the RCA is done outside of the primary RCA in a facility where there is no air sampling system. The facility has radiological controls and access is controlled by Radiation Protection personnel.

#### **7.6. RADIATION PROTECTION SUPPORT DURING EMERGENCIES**

During plant emergencies, the Technical Support Center personnel are responsible for the radiological protection of the Brunswick NPP employees on site and the Emergency Operation Facility personnel are responsible for the radiological assessment of the radiological consequences off site. RP technicians are responsible for effective utilization of portable radiological instruments and can be incorporated in off-site monitoring groups. Detailed description of radiation protection support during emergencies is described in Emergency Preparedness part of the Technical Notes.

## DETAILED RADIATION PROTECTION FINDINGS

### 7.1. ORGANIZATION AND FUNCTIONS

- 7.1(a) Good practice:** The site uses low dose waiting areas within the RCA where workers can rest or prepare for further activities while staying out of high radiation fields. This area could be further equipped with safety posters or performance indicator panels.

Special low dose waiting areas equipped with air conditioning is located on the refuel floor. This measure seems to be a good practice for workers wearing personnel protective equipment/clothing to protect them against heat stress. Also, there are designated drinking areas within the RCA where workers can drink after performing personnel contamination monitoring.

### 7.2. RADIATION WORK CONTROL

- 7.2(1) Issue:** Some radiation control practices may not provide sufficient protection against the spread of radioactive contamination. Examples include the following:

- Personnel are being contaminated in clean areas of the plant from March 11, 2005 until May 6, 2005. There are 21 cases where personnel became contaminated while in clean areas of the RCA. Eighteen of these individuals had shoe contaminations. No analysis of the cause of this has been performed.
- There is no requirement to monitor tools used in the clean areas of the RCA to identify the presence of loose surface contamination before returning them to the 'Hot Tool Room'. However, loose contamination on the surface of tools is checked by randomly taken smears. Only tools used in contamination areas are required to be regularly monitored for loose contamination. Monitoring of tools used in the radiologically controlled area (RCA) may prevent contamination from being spread to clean areas of the RCA. Based on the number of personnel contaminations in clean areas of the RCA a precautionary practice would be to monitor tools used in clean areas.
- There is not a systematic requirement to control radioactivity of waste debris from clean RCA areas before disposal into the green trash can.
- Personnel are inconsistent in removing their protective clothing when exiting a contaminated area. Some personnel were observed removing all of their protective clothing with their rubber gloves on which is contrary to plant procedures. On another occasion an individual removed a rubber glove before removing his rubber overshoes.
- Many of the personnel contaminations were attributed to improper radiation worker practices during the recent Unit 2 outage. (AR No. 00150326)

- Several instances of radioactive material being improperly handled, surveyed or disposed of have occurred. Several examples were noted as follows:
  - o A contaminated valve was placed in a clean metal waste bin (AR150735) inside the RCA
  - o A contaminated desk and tilt bin were transported to the clean trash monitoring facility outside the RCA. (AR157257) which was inside the radiation material area (RMA) within the owner controlled area.
  - o Contaminated metal from the insulation found at the RCA exit (AR147830). The AR further states that "though no radioactive material has been released off site, each event is a near miss and shows the need for an overall site wide improvement in radioactive material control".
- Work was being performed on a valve in the turbine building truck bay in a contaminated area. The door to the truck bay was left open during the work. There were no air samplers or friskers in the area to verify that contamination was not spread outside the truck bay. The workers were hammering on the valve as part of the rebuild effort which could dislodge contamination and spread it outside the contamination area.

Inconsistent contamination control practices may increase the potential for spread contamination outside of the radiologically posted areas.

**Recommendation:** The plant should review measures to prevent the potential of the spread of contamination within the RCA and make necessary changes.

**Basis:** IAEA safety standard ref: NS-G-2.7.

**7.2(a) Good practice:** Activities requiring a RWP are identified through the planning process. Work orders are generated in the plant information system and routed to the ALARA planner for review. Radiological planning is incorporated into the work order task, including an exposure estimate and the assignment of the task to the appropriate RWP.

Once the planning is complete, the scheduled activities can be queried by the computer to determine the radiological impact for a given time period. For example, a weekly or project exposure estimate can be generated using values previously captured in work order tasks. These projections are shared with the site work force prior to beginning the work. The actual exposure is tracked against the estimate and discussed with management at the daily morning meeting. The exposure history is useful information in future planning and projections. It is also a good tool for goal setting.

The work schedule is reviewed 10 weeks prior to implementation to ensure that the necessary radiological planning requirements can be implemented prior to performing work. This advanced look allows the RC group to be proactive instead of reactive, for example, in setting up areas for future job support.

The RWP instructs the worker on actions to take if an alarm is received or if radiological conditions change. If an alarm is received the dosimeter is locked until data can be retrieved.

**7.2(2) Issue:** The physical layout of access to, and posting of, some radiologically controlled areas could be improved to minimize the potential spread of contamination and radiation exposure. Examples include the following:

- Sorting of potentially contaminated trash collected from within the RCA is done outside of the primary RCA at the clean trash monitoring facility where is no air sampling system. The facility is not classified as a RCA despite part of the trash having the potential to be slightly radioactive. The facility has radiological controls and access is controlled by radiation protection personnel.
- In some areas of the reactor building some radiological postings (without additional information concerning the radiation risk) are confusing. In the reactor building there are many radiological postings without any information regarding the radiological conditions. This makes it more difficult for the workers to determine the actual radiological conditions. Too many radiological postings without any amplifying information may make the workforce less sensitive to radiological postings.
- Access to the hot machine shop is not locked and is protected only by a warning sign on a rope. As a result entry is possible without appropriate permission and knowledge of the RP technicians.
- There are some cases where there is a potential for radioactive material to escape from the posted RCA. For example, the clean trash monitoring facility and the low level radioactive waste building have multiple pathways for air flow to the atmosphere. Also, some areas are not equipped with a ventilation system.

Without an adequate setting and arrangement for the RCA boundaries and for the access and exit from the RCA areas, the risk of spreading contamination could occur.

**Suggestion:** The plant should consider reviewing the present layout of the RCA, contamination areas, radioactive material areas outside the RCA to improve radiation control and eliminate the potential spread of contamination.

**Basis:** IAEA safety standard ref: NS-G-2.7, para. 3.4.

#### **7.4. RADIATION PROTECTION INSTRUMENTATION, PROTECTIVE CLOTHING AND FACILITIES**

**7.4(1) Issue:** Personnel Contamination Monitors (PCMs) calibration should be enhanced at the plant.

- The calibration of APTEC Personnel Contamination Monitors (PCMs) may not be performed with a source that is representative of the radioactive contamination in the plant. The station is using Technetium 99 based on the result of a 2001 analysis that does not currently correspond to the distribution of the radioisotopes in the station.
- An inspection and response check of the APTEC PCMs is required and performed on a monthly basis. NGG instrument peer group prepared a proposal for daily recheck.

- ALARM of APTEC monitors has to be set at 5 000 dpm based on Co-60, but technetium 99 is used for this calibration.
- APTEC PCMs calibration procedure does not prescribe which calibration source and response check source has to be used.
- Radionuclide analysis and the average beta energy calculation is done on the Waste Characteristic Summary (type DAW-U-NA 55 Gal. Drum, last analysis dated 11/12/2004) instead of the radionuclide composition present in the posted contamination areas where workers are most likely to become contaminated. The average beta energy from analyses in these areas may be different.

Using a calibration radiation source for instrumentation calibrations with a different energy level than the primary energy level found at the station and inadequate response check period could cause an instrumentation to respond incorrectly.

**Suggestion:** The plant should consider reviewing methodology and procedures relating to the radiation protection instrumentation calibration and source check response.

**Basis:** IAEA Safety Standards Series No. RS-G-1.1, para. 5.46

**7.4(a) Good practice:** The station uniquely uses equipment to reduce exposure, provide information, and improve productivity:

- The BNP Camera Programme fosters increased productivity, improved exposure monitoring capabilities, exposure reduction, and has led to significant site improvements. BNP has installed over 70 cameras strategically throughout the station.
- The BNP Area Radiation Monitoring Programme fosters increased productivity, improved monitoring capabilities, exposure reduction, and has led to significant site improvements. BNP has installed over 220 remote detectors throughout the station. The enhanced radiation monitoring is in addition to plant installed radiation monitoring and is available for viewing at a central location or locally within the building where the detectors are installed.
- The BNP Personnel Remote Radiation Monitoring Programme fosters increased productivity improved monitoring capabilities, exposure reduction, and has led to significant site improvements. BNP actively utilizes over 100 remote detectors during outages and in high radiological or high collective dose situations. The personnel radiation monitoring utilizes a centrally-distributed concept that allows for viewing by either a central location or any monitoring station on the plant site.
- At Brunswick four basic types of high efficiency particulate air (HEPA) filter units are utilized. The HEPA units are typically used to support small scale work in contaminated areas but large scale units are typically utilized during outage periods to support large scale work. Additionally, these units are shared among NGG and other utilities as the need arises.

Large HEPA units can maintain a negative pressure on vessels or filter housings. Negative pressure helps to control particles within the vessels, keeps a constant airflow to support hot work, smoke removal, and when used in conjunction with charcoal filtration units, mitigates iodine airborne

## 8. CHEMISTRY

### 8.1. ORGANIZATION AND FUNCTIONS

At the Brunswick Nuclear Plant (BNP) the Environmental and Chemistry Organization (E&C) is responsible for optimizing plant chemistry in order to minimize corrosion of plant systems, reduce the in-plant radiation level and to minimize environmental impact. The E&C superintendent reports to the manager of environmental and radiation control (E&RC).

The staff is informed of the plant's policy and applies "safety first" in the field as personnel are regularly trained in this area.

Formal job descriptions are not available; however responsibilities within the group are clearly assigned.

E&C calculates and assesses regularly several indicators e.g. the INPO Fuel Reliability Indicator (FRI) and the Chemistry Performance Indicator (CPI). In addition, there are other internal and external indicators e.g. the environmental index and indicators for radioactive gaseous and liquid effluents. Responsibilities for calculation and assessment are clearly defined. Deviations from target values are analyzed and communicated. If target values of internal indicators are too high they are reduced to improve E&C's performance.

Self assessments on different topics like data management and laboratory quality control are carried out regularly. The results are analyzed thoroughly in a Nuclear Condition Report (NCR) and a corrective action plan is developed. The implementation of the actions is tracked, using the Passport application.

E&C is supported and advised by two corporate laboratories. For the purpose of environmental analysis and damage analysis. These laboratories are accredited. Although a contractor operates the demineralized water plant, the final quality of the demineralized water is controlled by E&C. Delivered diesel fuel is analyzed by a laboratory that is approved by Progress Energy.

Interface responsibilities e.g. with operations and radiation protection are properly defined and understood.

E&C participates regularly on external information exchange meetings, e.g. organized by INPO. Minutes of the main topics are made available to staff and lessons learned are implemented into daily work.

E&C is immediately informed if operational conditions change and chemistry may be influenced. However, improvement in the performance and reliability of the hydrogen injection system is needed.

Two shift chemists are always on site, therefore E&C can react very quickly to system changes. E&C participates in the Emergency Response Organization, and additional chemists are on-call if needed.

Depending on the knowledge and work history of new employees, an Individual Development Plan (IDP) is developed. The training is performed in classrooms and on the job. Success of the training is evaluated by specially assigned technicians and finally approved by the



organization's manager. The approved qualifications for each employee are summarized in a matrix and therefore easy to track.

E&C supervisors attend all trainings and the E&C Superintendent conducts one training session per cycle and attends other training sessions. Training material, e.g. hydrogen and zinc injection, is very well developed. Staff personnel appreciate the training very much and feel well prepared for the job.

E&C organisation is sufficiently staffed. Besides chemists with management responsibility there are several specialists without management function who can focus on projects and advise the organization. However, during the last reorganization one of these specialist positions has been eliminated and in the near future some chemists are going to retire. The Team encourages the organization to secure the experience transfer. This is the especially important since Progress Energy has applied to extend the lifetime of the plant.

Job rotation within the radiochemistry and the chemistry group is well organized and practiced. However job rotation between both groups should be regarded as a useful means to fill up vacancies temporarily.

The group meets regularly and conducts well organized meetings with all levels of staff and on all relevant topics. Minutes of these meetings are made available to the staff. In addition, a meeting is held each morning with E&C personnel to discuss safety, human performance, plant status, and chemistry status. The staff is well informed on the plant status, which facilitates daily work and improves understanding of plant issues.

## 8.2. CHEMISTRY CONTROL IN PLANT SYSTEMS

The Nuclear Regulatory Commission has approved the Technical Specifications; the water chemistry control programme is based on these technical specifications and industry guidelines. Administrative instructions (AI) and procedures specify the technical specifications where appropriate, concerning limiting values, action levels and sampling frequencies of systems and parameters for all modes of operation. Guidelines are even more specific and describe laboratory internal tasks. All procedures and guidelines are provided and kept up to date on a local area network. Working copies in paper form are verified and changes are announced in the morning meeting to minimize the risk of working with invalid procedures.

Corrosion and radioactivity build up are properly monitored by E&C. Fission products are monitored to assess integrity of the fuel rods. E&C plays a fundamental role when leaking of fuel rods is suppressed by positioning control rods.

Shut down and start up procedures are clearly defined.

The chemistry control programme is appropriate for the material concept.

Plant modifications like the upgrade of the condensate polishing system (CDD) are made with strong support of E&C. The condenser tubes have been exchanged for new ones made of titanium.

The control programme for diesel fuel comprises all relevant parameters. The analyses are carried out regularly; the results are trended and have been within the specifications. Lube oil of important operational systems and emergency systems are mainly analyzed by a contractor and a corporate laboratory, and all relevant parameters are covered. Lube oil sampling is

performed by the mechanical maintenance group, and the results are evaluated by the engineering group. Sampling is done very thoroughly and provides reliable samples.

Plant internal limiting values keep the activity of effluents rather low and are a good example of the ALARA principle.

Chemical parameters are properly monitored and evaluated by E&C and if necessary by the engineering department. Technical specifications require the boron-10 concentration of the standby liquid control tank to be verified prior to any addition and not on a periodic basis. However, the procedure OAI-81 does not require determining the boron-10 concentration. The team provided a Suggestion in this area.

Parts of BNP's reactor vessel internals are made of thermal treated stainless steel, that is sensitive to intergranular stress corrosion cracking. Cracks have been observed by the plant in the external recirculation pipes and the core shroud. To reduce crack growth hydrogen is injected on the intake side of the condensate booster pumps. The condenser is very tight and oxygen is injected on the intake side of the condenser pumps to protect the carbon steel of the condensate system with a stable oxide layer. The influence of the electrochemical potential (ECP) on the behaviour of corrosion products is well understood in E&C. Downstream of the low pressure heaters depleted zinc is added to the water steam circuit to reduce activity build up. Although the chemistry performance indicators (CPI) are very good, consideration should be given to further reduce even more the concentration of IGSCC promoting ions in the reactor water and feed water. Excursions of corrosion inducing ion concentrations as occurred in 2004 due to a resin intrusion should be avoided.

The hydrogen injection system does not work very reliably, especially since the power upgrade of the plant. The team provided a recommendation in this area.

The condensate deep bed demineralizers (CDD) were upgraded between 2002 and 2005 and the mechanical pre-filters (CFDs) were upgraded in 1994. The performance of the mechanical filter has improved considerably. The conductivities are low on both sides of the filters and close to the lowest theoretical value. Online sodium monitors at the condenser and effluent side of the CDD system monitors the condition of the system for possible condenser leaks.

The water steam circuit of Unit 1 has elevated boron concentration due to control rod defects. The reactor water clean up filters of Unit 1 therefore have to be exchanged more frequently, thus producing more radioactive waste. In addition more tritium is produced. Decontamination factors for the filters are calculated if necessary. The plant already manages this issue and plans to replace control rods in the next refueling outage.

Although the condenser is made of titanium several leaks were detected during the last few years. E&C champions localizing the leaks with helium mass spectrometer.

The closed cooling water systems for the reactor buildings, the turbine building and the diesel jacket cooling are stabilized with sodium nitrite and tolyltriazole. They are monitored regularly with regard to e.g. the stabilization chemicals, corrosion inducing ions and bacteria. The results are within the specifications.

The reactor building closed cooling water circuit for Unit 1 is contaminated due to a heat exchanger leakage several years ago. The activities of the fission products are far below a level where action is needed as defined in the 'Water Chemistry Guideline' procedure.

BNP replaced the first make up plant for demineralized water with a modern plant, which uses mainly different membrane techniques to produce demineralised water from county water. The plant is operated by a contractor. The quality of the product is controlled by suitable inline instruments, which are regularly crosschecked by E&C. The new plant does not require handling large amounts of caustic chemicals for regeneration purpose. However, the produced demineralized water is stored in a tank without protection against airborne pollutants. To reduce impurities in the storage tank, the tank is regularly overfilled. A chemical air filter system could be considered by the plant since the quality of demineralized water is a very important factor as some anions promote corrosion.

### 8.3. CHEMICAL SURVEILLANCE PROGRAMME

Procedures and methods of analysis are clearly understood and properly followed. An electronic plant work management system schedules the daily periodic analytical programme and keeps track of all tasks. The system is supplemented by an E&C internal electronic scheduling programme.

The sampling plans cover all systems and parameters, and the sample frequencies are appropriate. The boron-10 analysis of the liquid control storage tank is verified prior to any addition, but it is not periodically monitored.

Certified radiochemical standards for the calibration of the counting equipment are available for every geometry. They are catalogued electronically and the storage is well organized.

Calibration standards and control standards for chemical analysis are prepared from different stock solutions. They are labelled with the preparation date and the expiration date. The expiration date depends on the concentration of the standard. Standards with low concentration are prepared every day. Certificates of the standards are available in the labs.

The optical emission spectrometer (ICP-OES) is used for the measurement of corrosion products. The Team observed that the concentration of measured samples were higher than the standard concentration used in the calibration. Although the instrument was checked with a standard above the sample concentration, this is not conforming with good laboratory practice (GLP). Some statistical tests, e.g. test on linearity are not carried out or are not documented. This is important as linearity has to be proven especially when matrix effects must be taken into account as some of the samples are digested with aqua regia. The team provided a suggestion on this subject.

Plant's dose rates are discussed in the daily morning meeting. E&C doses and measures to minimize them are discussed weekly.

In addition to the E&C laboratory supervisor, there is one technician assigned responsibility for quality control. They are responsible for preparing the quarterly report for the head of the laboratory.

E&C performs quality control checks and participates regularly in inter laboratory tests in the chemical and radiochemical area that cover all relevant parameters. A 'Quality Assurance Problem Report' is written when deviations are detected. This report describes in detail the problem and the countermeasures taken, as well as the influence on previous samples.

Corrective actions following chemistry results are timely since E&C is authorized to adjust most chemical parameters.

Chemistry results are entered to the Chemistry Data Management System (CDMS). CDMS provides a first consistency check on the data, as it compares the entered data with previous data and requires some comments if deviations are detected. Trending graphs can be easily generated, as this tool is frequently used to verify the consistency of the results. The results are crosschecked by the E&C laboratory supervisor. If deviations are detected a Nuclear Condition Report (NCR) is initiated for further assessment.

The data are stored as paper documents which are sent to the vault regularly. They are also transferred to CDMS, which is also regularly backed up.

E&C has an electronic and hardcopy laboratory log book that is combined with the log book of operations.

In addition to the data from CDMS, E&C has access to the operational process computer. This data can be viewed online. The daily 'Environmental and Chemistry Status Report' is generated automatically, thus excluding human errors in data transfer. This report is approved by E&C. All data can be combined with limiting values and, if these values are reached, sent via radio to the pager of the laboratory supervisor. It is also possible to send all the values or a selection of values periodically to the pager. This reduces action times significantly. The team recognizes this as a good practice.

#### 8.4. CHEMISTRY OPERATIONAL HISTORY

Responsibilities for reporting and assessment are clearly assigned. The "Daily Environmental and Chemistry Status Report" is distributed and evaluated at the daily morning meeting. It is available on the intranet and is open to the NRC. However, the very sophisticated quarterly "Chemistry Report" on primary and secondary chemistry and gaseous and liquid effluents is approved by the E&C Superintendent and not formally distributed outside of the E&C organization.

Trending of the activated corrosion products and the correlation with hydrogen and zinc concentrations is not reported as a key parameter to upper management.

The necessity of a reliable hydrogen injection system has received appropriate attention very late. (See paragraph 8.2 of this report.)

Operational experience from WANO and INPO is reviewed and communicated and well implemented into the work of the group.

#### 8.5. LABORATORIES, EQUIPMENT AND INSTRUMENTS

The laboratories are spacious and very clean. The technicians have taken ownership. To reduce contamination risks and to facilitate paper work each technicians has an office place outside the laboratory. Enough space with fume hoods is available; and each fume hood is equipped with an optical flow meter. However, there is no alarm, when the ventilation system breaks down. The team provided a suggestion in this area.

Emergency equipment (showers and eye washes) is available and tested regularly. However, some flammable liquids like acetone and alcohol are stored in a cabinet that does not have a ventilation system.

Reactor accidents should have no impact on the availability of the laboratory. However, as a contingency samples can be shipped to off-site laboratories for analysis.

The chemical and radiochemical laboratories are equipped with modern instruments but also some older ones. There is no redundancy for the optical emission spectrometer on site. Handbooks are available in the lab and are used readily by the staff. Maintenance done by E&C on the instruments is documented in electronic and paper logbooks, however these logbooks contain no information on responsibilities and authorizations for the systems. Installation reports and maintenance reports from the vendor are not archived systematically. Information on good practices was exchanged during the review. Control charts are available for many of the instruments, however not for all, e.g. the optical emission spectrometer, the conductivity meter and the pH meters. Control charts are available for instrument analytical recovery parameters but not for chemical blank values. The team provided a suggestion in this area.

Several online conductivity meters, sodium meters, hydrogen meters and oxygen meters are installed where appropriate. It should be stressed that E&C also operates an online ion chromatograph to continuously monitor the zinc concentration and the concentration of corrosion inducing ions in the reactor water. This minimizes the time to detect chemistry changes and it reduces the contamination problem at low ion concentrations. In addition there is an online TOC meter installed to monitor the quality of the waste demineralizer. All online instruments are regularly checked with calibrated off-line laboratory instruments or with standard solutions.

The alternate post accident sampling system is designed to obtain samples from the coolant and the atmosphere of the containment. The samples can be diluted to reduce dose rate. Corrosion was seen on the system, e.g. the magnetic valves, and several tools and some tubes were inside the operating panel. (See Maintenance section of this report.)

The transport cask for the samples was also degraded due to corrosion. A C-clamp, which should prevent roll off during an earthquake, was not fixed to the wheels. (See Maintenance section of this report). An NCR was initiated. A special place in the hot lab is designed for the handling of the samples. At this time 9 E&C technicians are authorized to operate the system.

The system is tested every two years. The results are in compliance with routine samples.

The transport cask for the samples was also degraded due to corrosion. A C-clamp, which should prevent roll off during an earthquake, was not fixed to the wheels. (See Maintenance section of this report). An NCR was initiated. A special place in the hot lab is designed for the handling of the samples. At this time only 9 E&C technicians are authorized to handle the system.

The system is tested every two years. The results are in compliance with routine samples.

#### 8.6. QUALITY CONTROL OF OPERATIONAL CHEMICALS AND OTHER SUBSTANCES

BNP has an approved list for all chemicals brought on site. These materials have to fulfil certain requirements concerning corrosion inducing element concentrations. The materials have a colour coded label to facilitate their allowed application area in the plant. However there is not a physical control at the entrance of the radiological control area to exclude non approved material. BNP focuses on training of the staff and contractors to know about the

possible risks for the integrity of the plant. Material Safety Data Sheets (MSDS) are available as paper hard copies and via internet. Chemicals must be stored in cabinets, which are regularly checked, special cabinets are designed for waste and reusable chemicals. The responsibility for the individual cabinets is clearly assigned. Installation of new cabinets is only permitted with the approval of E&C.

In the chemical storage room in Unit 1 a leaking hand pump was found that was repaired with inappropriate materials. Also, there was some debris behind some barrels with detergents. This problem was fixed promptly during the mission.

In the old SPA chemical storage area a number of different chemical substances are stored outside and within special cabinets. In this room housekeeping should be improved.

Operational chemicals are ordered with technical specifications. Warehouse staff is instructed to compare the vendor's receipt with the technical specifications, e.g. for resins and boron. To determine the capacity of deep bed resins (CDD) an identity check is carried out. An identity check for lube oil is not required. The team provided a suggestion in this area.

E&C performs an identity check on the delivered diesel fuel prior to unloading.

The warehouse is air conditioned. Shelf lives are provided by the vendor or determined by E&C. They are well considered and tracked with the Passport application. Goods that have exceeded their expiration date are tracked and removed from the storage to prevent use.

## DETAILED CHEMISTRY FINDINGS

### 8.2. CHEMISTRY CONTROL IN PLANT SYSTEMS

**8.2(1) Issue:** The chemical control program of some plant systems, and its implementation with the receipt process for chemicals used in plant systems could be improved.

- Natural borax is stored in the same room with boron-10. The different packing of natural and enriched boron is not a suitable help to reduce risk of mixing.
- The current practice of analyzing boron-10 prior to use is in accordance with technical specifications however, procedure AI 81, does not include determining the boron-10 concentration on a routine frequency.
- The reactor building closed cooling water circuit for Unit 1 is contaminated due to a heat exchanger leakage several years ago. The activities of the fission products are far below OAI-81 action level 1 but they exceed action level 0.
- The resins of the reactor water clean up system do not pass a chemical identity check. However the resins for the condensate polishing system do pass this check. Proper ion exchange resins are an important prerequisite for low ion concentration thus reducing further intergranular stress corrosion.
- Lube oil does not pass a systematical chemical identity test. Lube oil is spot checked; however, it is not required by a procedure.

Without a comprehensive chemical control programme the reliability of systems can be endangered. Procedures must be consistent with the practices to not be confusing.

**Suggestion:** The plant should consider further improving its chemical control programme for plant systems and in the receipt process for chemicals used in plant systems.

**Basis:** IAEA-TECDOC-489 para 2.2.1

**8.2(2) Issue:** The hydrogen water chemistry system performance and reliability are not meeting plant standards.

- The hydrogen injection system on Unit 2 tripped five times in January 2005 due to balance problems with injected oxygen and 16 times in April 2005 due to power upgrade of the plant which went along with a pressure increase in the condensate system. The problems with the hydrogen system date back to 2001. Nevertheless the team recognizes that upgrading the hydrogen injection system has now a high priority on the equipment priority list.
- Unit 1 did not achieve the Hydrogen Water Chemistry (HWC) Trips goal for 2004 and Unit 2 will not achieve its goal in 2005.
- The HWC system is designed to operate above 30 percent reactor power, however, the system does not run reliably below 70 percent power.
- Trending of the activated corrosion products and the correlation with hydrogen and zinc concentrations is not reported as a key parameter to upper management. The necessity of reliable injection systems has recently received appropriate attention.

Without a reliable hydrogen water chemistry system inter granular stress corrosion in reactor pressure vessel interiors may not be minimized.

**Recommendation:** The plant should adapt its programme to improve the reliability of the hydrogen water chemistry system.

**Basis:** IAEA-TECDOC-489, para. 2.2.1

### 8.3. CHEMICAL SURVEILLANCE PROGRAMME

**8.3(a) Good practice:** The Environmental and Chemistry organization has access to the operational process computer and the Chemistry Data Management System via pager. This data can be viewed online. The daily "Environmental and Chemistry Status Report" is generated automatically, thus excluding human errors in data transfer. The report is approved by E&C and distributed in the daily morning meeting. All data can be combined with limiting values and, if these values are reached, sent via radio to the pager of the E&C laboratory supervisor. It is also possible to send all the values or a selection of the values periodically to the pager. This significantly reduces action times of E&C.

**8.3(1) Issue:** Some areas in the performance of the E&C organization is limited due to a lack of characterization of analytical methods and chemistry documentation management.

- Some chemistry samples have a higher concentration than the standards used to calculate the instrument. Good laboratory practice (GLP) is to calibrate the instrument so that the sample measurements are between the lower and upper calibration concentrations. The station uses a verification standard that has a higher concentration than the sample to verify that the instrument response is accurate; however this point is not included in the calibration curve.
- Some statistical tests, e.g. test on linearity and homogeneity of standard deviations are not carried out or are not documented. This is important as linearity has to be proven especially when matrix effects must be taken into account as some samples are digested with aqua regia.
- It is not tracked and documented which laboratory technician prepared a chemical calibration standard, neither on the flask itself nor in a log book.
- Instrument logbooks do not include all relevant information such as responsible person(s), vendor support, maintenance contract numbers, and component identification.
- Instrument installation reports and maintenance reports from the vendor are not systematically archived.
- Quality control charts are available for most analytical instruments; however, quality control charts are not available or produced for instruments such as the optical emission spectrometer (ICP-OES), conductivity meters, and pH meters.
- Control charts are available for instrument analytical recovery parameters but not for chemical blank values.



Without a proper characterization of analytical methods and documentation the reliability of analytical results is not guaranteed and may result in a wrong decision which might have negative impact on the plant chemistry.

**Suggestion:** E&C should consider improving the characterization of analytical methods and its documentation management.

**Basis:** IAEA Safety Standard NS-R-2 para 2.3(4).

## 8.5. LABORATORIES; EQUIPMENT AND INSTRUMENTS

### 8.5(1) Issue: Handling and storage of chemicals in some areas could be improved.

- There is an optical indicator for performance of the ventilation system in the chemistry lab; however there is no alarm, when the ventilation system fails.
- Some flammable liquids like acetone and alcohol are stored in a cabinet without ventilation system.
- The ventilation system in the storage room for chemicals to be used in the maintenance (OLD SPA) area is functional, but there is no visible sign in place to quickly check that it is functioning.
- The electrical lights in the OLD SPA are not explosive protected.
- In the chemical storage room for detergents in unit 1 a leaking hand pump was found, that was repaired with tape and tissue. Also there was some debris behind some barrels with detergents. This problem was fixed promptly within the mission.

Improperly handling and storage of chemicals may adversely impact the environment and may result in serious injuries of the employees.

**Suggestion:** The plant should consider improving handling and storage practices in the chemistry area and benchmark against international standards.

**Basis:** IAEA TECDOC 489 para 1.4.

## **9. EMERGENCY PLANNING AND PREPAREDNESS**

### **9.1. EMERGENCY ORGANIZATION AND FUNCTIONS**

The emergency preparedness activity is regulated by three federal organizations, the Nuclear Regulatory Commission (NRC), the Federal Emergency Management Agency (FEMA) and the Environmental Protection Agency (EPA). The legally binding regulatory prescriptions are compiled in Chapter 10 of Code of Federal Regulations. The NRC and the FEMA have jointly issued two NUREG guidelines (NUREG-0654 and NUREG-0696) describing the suggested approach, how the Brunswick Nuclear Plant (BNP) should fulfill the expectations during its emergency preparedness and response activity.

Emergency planning zones (EPZ) around the plant are determined based on the most severe emergency situation as determined in the 'Final Safety Analysis Report' of the BNP according to the relevant NUREG guideline, additionally the emergency planning zones are indicated in the operating license of the BNP. The radius of the smaller one called Plume Exposure EPZ is 10 miles, while of the larger one called Ingestion Pathway Zone is 50 miles.

The most important roles in off-site emergency response are assigned to the home and neighbor county (Brunswick and New Hanover) and to the State of North Carolina. Both the counties and the state possess well-equipped and staffed emergency centers in order to handle emergency situations.

The cooperation of on-site and off-site organizations is based on (1) contracts, (2) letter of agreements either signed by the leader(s) of the off-site organization and addressed to the BNP Emergency Preparedness Supervisor, or signed by plant representatives at different levels and addressed to the leaders. Additionally (3) Task Force Meetings are held every two months together with the off-site counterparts. Liaison officers to the BNP are assigned at each off-site organization for radiological emergency preparedness.

The off-site emergency management is integrated, which means that different events are managed by the same staff (delegated by competent off-site public authorities), the only difference that in the case of a radiological emergency the representatives of the nuclear plant are also involved, and through them the decision making is supported by the plant's emergency response organization.

The emergency planning and preparedness activity of the BNP is coordinated by a 5-member section headed by the emergency preparedness supervisor within the support services organization. This section among others prepares the Emergency Response Plan (ERP) and the implementing procedures, organizes the emergency preparedness training, drills and exercises, maintains the emergency equipment, and keeps contact with the off-site response organizations. Though this section has the main responsibility, other plant's organizations also participate in emergency preparedness activity by reviewing processes, maintaining certain procedures or emergency equipment.

The management expectations of the employees are clearly defined. Each employee has three different functions: normal task, outage task and emergency response task; involvement into all three duties is expected. Consequently almost every employee (plus the security guards) has, depending on his/her own position in the plant's organization, role in the emergency response organization. It means altogether 690 individuals, who are divided into 5 teams; each team can completely fulfill all emergency response functions.

The self assessment and operational experience programmes efficiently support the improvement of the preparedness activity, while the benchmarking programme provides good practice from other utilities.

## 9.2. EMERGENCY PLAN

The Emergency Programme for the Brunswick Nuclear Plant consists of the Brunswick Radiological Emergency Plan and its implementing Plant Emergency Procedures. Also included are the related radiological emergency plans and procedures of state and local organizations. The purpose is to provide for the protection of plant personnel and the general public and to prevent or mitigate property damage that could result from an emergency at the Brunswick Nuclear Plant. The team found that the combined emergency preparedness programmes effectively ensures the (1) effective coordination of emergency activities among all organizations having a response role, (2) the early warning and clear instructions to the population-at-risk in the event of a serious radiological emergency, (3) the continued assessment of actual or potential consequences both on site and off site. (4) effective and timely implementation of emergency measures, and (5) the continued maintenance of an adequate state of emergency preparedness.

In accordance with the good international practice, integrated emergency management exists at BNP: fire plan, security plan and radiological emergency plans are established. The radiological ERP covers the nuclear, radiological, industrial emergencies and severe weather conditions. The ERP is approved by the emergency preparedness supervisor and it is submitted to the NRC within 30 days of its approval. Beyond the very good informal connections between the on-site and off-site organizations the plant emergency preparedness section is formally involved into the review of the radiological part of the off-site plans, which support the NPP. Regarding the formal participation of off-site organizations in the review of the ERP and the applied emergency classification procedure the team suggested improvements in this area.

## 9.3. EMERGENCY PROCEDURES

In addition to the ERP 35 implementation procedures are established. The team found these procedures properly developed, maintained and annually reviewed. The review is made both by a sub-committee of the BNP Nuclear Safety Committee (independent review) and the emergency preparedness section. The involvement of this sub-committee into the review process ensures that the opinions of other plant organizations are also considered. Based on their suggestions the necessary corrections are implemented and a new version is prepared. All procedures are approved by the emergency preparedness supervisor.

In the event of an emergency the shift superintendent is in charge for classifying the emergency via the emergency classification procedure and for informing the off-site organizations within 15 minutes. If the situation is promptly classified as general emergency, then suggested protective actions based on predetermined scenario are sent to the off-site organizations as well. When the severity of the incident is to be classified, the shift superintendent orders the alerting and activation of the plant's emergency response organization. A computerized pager and call-back system facilitates the rapid and effective activation of the response personnel. The primary means to protect the workers not involved into the emergency team on duty is evacuation. Dedicated and alternate assembly points are determined, where the individuals are accounted for and the non-essential are then evacuated.

After the set-up of the emergency response organization the assessment of the technological situation independently of the control room and the monitoring of the environment (plume tracking) are started. Based on either stack measurements or source term estimations and the actual weather conditions the radiological support team will evaluate the environmental consequences and develops suggested protective actions to the off-site organizations by using the same software (RASCAL) that is used by all off-site organizations. The termination of the emergency is a cooperative decision of the off-site and on-site emergency organizations. Subsequently the preparation for the recovery phase starts inside the plant.

Injured or contaminated personnel are treated immediately by the emergency first responders, who are auxiliary operators on shift, then they are transported to the nearest, contracted hospital.

The team found as good performance how the plant pays special attention to emergencies caused by severe weather conditions. The preparedness activity commences two-three months prior to the hurricane season. In case of real hurricane two emergency response teams are ordered into the site and they are there until the weather conditions become stable; furthermore the units are downloaded to hot shutdown state.

The team suggested improvements in the area of on-site evacuation. Electronic alerting and call-back system was recognized as a good practice by the team.

#### 9.4. EMERGENCY RESPONSE FACILITIES

The team found that the emergency response facilities both on-site and off-site are well equipped and maintained. The on-site emergency centers are protected by isolated ventilation system and supported by uninterruptible and emergency power supply. The long term operation is ensured by water and special food reserves. Dependent on the radiological situation the emergency centers may be set-up within a short time in alternate locations.

The plant has four emergency response centers: (1) The connections with the off-site organizations and the coordination of the on-site emergency activities are managed by the Emergency Operations Facility, (2) the control room personnel are supported by the Technical Support Center, (3) the Operational Support Center ensures support to auxiliary operations, while (4) the media and public information is performed by the Joint Information Center.

Off-site emergency centers are located in the off-site emergency directors' headquarters in both neighboring counties and the State of North Carolina.

Advance communication and data exchange system is established between the centers as a combination of phone, fiber optic, microwave net, data links as radio for phone, fax, computer and radio communication.

In the event of a radiological emergency the environmental monitoring is performed solely by monitoring teams since external environmental area radiation monitors are installed neither on-site nor off-site around the plant.

The team suggested improvement regarding environmental monitoring of the plant.

## **9.5. EMERGENCY EQUIPMENT AND RESOURCES**

The emergency response centers receive information on the plant conditions via direct communication with the control room. Additionally the computerized plant safety parameter system can be reached from each emergency center.

Should the on-site meteorological data collection system exhibit suspect information, loss of data due to computer or instrument failure, or plant personnel require additional technical assistance, meteorologists are available to provide needed expertise. Meteorologists can independently access on-site meteorological data, contact the National Weather Service to obtain additional synoptic scale weather data and compile a site specific atmospheric diffusion assessment for BNP site. The data of seismic, inside radiological monitors and fire detectors are also available.

Two vehicles, which are used by radiation protection personnel during normal operation, are dedicated to environmental monitoring. The environmental monitoring personnel are well trained for using the detectors designated for emergency response. The plant is well prepared for decontamination of humans and vehicles.

## **9.6. TRAINING, DRILLS AND EXERCISES**

Organizational preparedness is maintained through a well-managed, integrated emergency planning training program that includes general orientation of all persons at the site and detailed training of individuals and groups required to perform specific functions and actions during an emergency condition. The training program provides initial training and annual (continuing) retraining of the emergency response organization. Each individual, other than escorted personnel, is provided with initial orientation training on the notification and instruction methods used at the BNP in the event of an emergency, additionally the each badged individual receives initial orientation on the basic principles of radiological safety including the effects of radiation and the theory and use of radiation detection devices.

The 'Emergency Plan Training Programme' assures training of those individuals who may be called to respond to an emergency at the BNP by providing initial training and annual refresher training and retesting on the scope and content of the Plan and procedures which implement the Plan.

The 'Emergency Plan Training Programme' covers also members of off-site organizations who may be requested to assist in an emergency. Training by Progress Energy for hospital, ambulance, rescue, police, and fire personnel includes the procedures for notification, basic radiation protection, and their expected roles.

Emergency drills are supervised instruction periods aimed at testing, developing and maintaining skills, and to ensure that adequate emergency response capabilities are maintained during the interval between exercises. Periodic drills are conducted involving a combination of some of the principal functional areas of the organization's onsite emergency response capabilities. Participants have the opportunity to consider accident management strategies (supervised instruction is permitted), and to resolve problems (success paths) rather than have controllers intervene. Communications drills are organized monthly to test the readiness of the communications network between the plant and state and county governments within the 10-mile emergency planning zone and the NRC. Communications between the plant, federal emergency response organizations, and states within the 50-mile

EPZ are tested quarterly; while communications between the plant, state and local emergency operation centers and field assessment teams are conducted annually. Additionally fire drills, medical emergency drills, radiological monitoring drills, radiation protection drills, and augmentation drills are periodically organized. An emergency exercise aiming at testing the integrated capability of major response organizations is conducted once every two calendar years and it is based on a scenario which is ultimately declared at least as a Site Area Emergency and it covers all main activities of the plant's emergency response organization. Every sixth year, the exercise is expanded to allow involvement of the federal response organizations in addition to the state and local organizations. The team recognized the comprehensive and frequent exercising system of the plant as good performance.

Due to the location of the plant real weather conditions require time to time the activation of the emergency response organization and evacuation of the population from the coast. Such a way the shift turnover is exercised, while the population is prepared for immediate evacuation and well prepared and validated off-site evacuation plans exist.

Critiques are prepared by independent observers after every drill and exercise, as a basis on which the Emergency Preparedness Supervisor determines the corrective actions necessary and the schedules for performing them and evaluates the corrective actions taken. The tracking of corrective actions is made in the frame of the plant 'Corrective Action Programme.'

#### 9.7. LIAISON WITH PUBLIC AND MEDIA

Occupants in the plume exposure pathway emergency planning zone (EPZ) are provided information prepared by Progress Energy in conjunction with the state and county agencies. According to the team's experience it is a good performance that the public education and information program is intended to ensure that members of the public are: (a) aware of the potential for an occurrence of a radiological emergency; (b) able to recognize a radiological emergency notification; and (c) knowledgeable of the proper, immediate actions to be taken upon notification. This is accomplished by: (1) distribution of the annual safety information brochure which contains educational information on emergency preparedness, sheltering, sirens, radiation, and telephone numbers of agencies to contact for more information; (2) availability of qualified personnel to address civic, religious, social and occupational organizations; and (3) distribution of news material to the media and numerous community and business newsletters. Emergency information is made available to transient populations through the distribution of safety information brochures to commercial establishments (businesses, hotels, etc.) in the 10-mile EPZ.

Public warning when deemed necessary is accomplished as described in the North Carolina Emergency Response Plan in support of the Brunswick Nuclear Plant. Warning is given by such methods as sirens supplemented by radio, television, sound trucks, bullhorns, and knocking on doors. The warning system is reviewed annually and Progress Energy plans to upgrade them by replacing the old sirens to a new type.

During an actual emergency, provisions will be established through the Joint Information Center to make available and distribute information to the news media. The team found the plant emergency information activity as a good practice [see 9.6(a)].

## DETAILED EMERGENCY PLANNING AND PREPAREDNESS FINDINGS

### 9.2. EMERGENCY PLANS

**9.2(1) Issue:** The involvement of the off-site organizations in the review process of the Emergency Response Plan (ERP) and the applied emergency classification system do not guarantee the most effective international practice.

- The ERP is reviewed by the Plant Nuclear Safety Committee, revised by the emergency preparedness staff and approved by the emergency preparedness supervisor, but the liaison officers to the plant who are assigned at each off-site organization playing role in the event of a radiological emergency do not formally participate in the review.
- The Counties, the State of North Carolina and the federal organizations receive a hard copy of the plant effective ERP after approval, and they get only informal guidance about the modifications.
- The “Emergency Classification” is event based from nuclear technological point of view; additionally no clear reference exists between the EOPs and the Emergency Action Levels.
- In accordance with the classification system used only general emergency requires immediate off-site protective actions, but not only specific, predetermined, observable criteria are used as a basis of classification (e.g. security opinion, dose-rate projection, event that could cause, conditions that make large release possible, with potential loss of the third barrier).
- When the emergency may be classified by starting from different initiating events, then reaching the declaration of an emergency class on the flowchart requires the continuing of the assessment and consequently needless time.

Without the formal involvement of the competent off-site organizations into the review of the emergency plan, the consideration of their opinions can not be assured.

Decision criteria should not lead to any hesitation when declaring a general emergency. Without clear and measurable criteria for general emergency the implementation of protective actions may suffer unnecessary delay.

**Suggestion:** Consideration should be given to establish a formal system for off-site organizations to participate in the review process of the radiological emergency plan, and to provide supporting guidance for classification of emergency situations in terms of quantified and primary measured criteria. The use of monitored plant safety parameters in emergency classification (computerization) as a support to shift superintendent also should be considered.

**Basis:** IAEA Safety Standards GS-R-2 para. 5.19, para 4.3, para. 4.8, para 4.70, para 4.19, para 4.20, NS-R-2 para 2.31, EPR METHOD-2003, para 4.13.

### 9.3. EMERGENCY PROCEDURES

**9.3(1) Issue:** The procedure describing the methods for evacuation of the on-site personnel and the marking of the escape routes do not guarantee the proper management of accounting and evacuation.

- No accurate accounting of employees and visitors when entering the owner controlled area, and individuals leave the owner controlled area without control.
- Assembly points and alternate assembly points are clearly defined, and the control and registration of workers within the radiation protected area is properly solved by electronic badge registration, but no means exists to promptly establish who is on site at the start of an emergency inside the owner controlled area, but outside the protected area.
- The searching of individuals who are missing at the assembly points is prescribed in the relevant procedure, otherwise the systematic checking of rooms within owner controlled area, but outside the protected area is not prescribed in the relevant procedure.
- Emergency exit doors are marked by "Emergency exit" label and usually more "Emergency exit" doors exist in certain rooms, but they are not visible from any point within the vital area.
- The escapes routes leading to emergency exit doors are not clearly and durably marked with arrows either on the wall or the floor within the radiation protected area.

Without control of the number of individuals being in the owner controlled area of the plant, but outside the protected area: (1) any injured or unaccounted individuals may be not cared in time; (2) searching of individuals assumed to be missing may result in needless activity and unnecessary radiation exposure of the emergency workers (searchers).

The lack of clear and durable signing of the escape routes under the pressure of a real emergency or under decreased visibility conditions may result in unnecessary delay in the escape and evacuation to the assembly point.

**Suggestion:** Consideration should be given to improve methods for accounting/verifying individuals inside the owner controlled area, but outside the protected area. The plant should consider to enhance the marking of the optimal escape routes within the vital area.

**Basis:** IAEA Safety Standards GS-R-2 para. 4.51.

**9.3(a) Good practice:** Notification of Emergency Response Organization (Via Brunswick Emergency Notification (BEN) System)

BEN is a computer based Emergency Response Organization (ERO) callout and notification system. The computer system utilizes 36 phone lines to notify the ERO to respond to an event at the plant site. Upon activation BEN will automatically initiate digital and text group pages informing the ERO of the emergency classification, instructions on facility activation, and for minimum staffing personnel to call BEN



system. Once notifications are made BEN, accepts incoming calls from ERO members and qualifies ERO members by determining if they can respond promptly (<60 minutes) and also if they are fit for duty. As ERO members call in BEN fills ERO minimum staffing positions required for facility activation. After a predetermined time BEN will make outgoing calls to the ERO for positions not filled using individual pagers, home and work phone numbers, and cellular phones. Once all ERO positions are filled the BEN system will stop searching for ERO members automatically. An additional function of the system is to automatically fax in-progress rosters to the control room every 15 minutes until roster is completed. This gives the site emergency coordinator assurance that the ERO is responding. During BEN system testing minimum staffing has been verified complete within 15 minutes. On the completion of ERO minimum staffing being filled, BEN begins filling rosters for facility support staff and the Joint Information Center (JIC) as needed.

#### **9.4. EMERGENCY RESPONSE FACILITIES**

##### **9.4(1) Issue: The environmental monitoring capabilities can be improved.**

- Installation of continuous automatic on-line radiation monitoring system around the plant is international standard.
- Environmental monitoring teams make measurement in the case of a radiological emergency on locations decided by the plant emergency response staff based on weather conditions, but automatic on-line radiation monitors are not installed around the plant either on-site or off-site.
- The suggested protective actions are not supported by environmental measurement results prior to starting of the environmental monitoring.
- Automatic, continuous environmental measurements do not include into Emergency Action Levels (EALs).
- Emergency protection equipment provided to the environmental monitoring teams are not in accordance with the international good practice.
- The cars used in the case of an emergency are not equipped with special ventilation or filter system.
- The defined location for the parking of the two environmental monitoring vehicles on-site is in a parking lot within the site. Both vehicles could be contaminated in the event of an accident as the result of the fall out if they are at the same spot. However procedure exists for surveying and decontaminating the vehicle before use for monitoring, but it can result in delay in monitoring.
- The team members are provided with dosimeters and they should report the exposed dose to the team leader every 20 minutes; however, they have no any special protective equipment installed in the vehicle in order to protect them against radiation.
- The monitoring team does not wear protective equipment, because the mask bothers the workers in driving the car.

Without continuous automatic on-line radiation monitoring, the suggested protective actions after the event may be based only on projected doses until environmental teams report.

Without adequate protection against radiation exposure the emergency workers involved into field monitoring could shortly receive the specified turn-back dose limit.

Without separate parking of the cars both vehicles could be contaminated in the event of an accident as the result of the fall out if they are at the same spot.

**Suggestion:** Consideration should be given to analyze and consequently enhance the environmental monitoring capabilities of the plant.

**Basis:** EPR-METHOD-2003 2.1.3, GS-R-2 para 4.71, RS-G-1.8 para 5.69 and para 5.73.

## 9.6. TRAINING, DRILLS AND EXERCISES

### 9.6(a) Good practice: Organization of drills and exercises, testing of the public information activity.

The plant conducts periodic drills and exercises to test the adequacy of the Plan and implementing procedures, emergency equipment, and the preparation and training of emergency personnel. Emergency drills are supervised instruction periods aimed at testing, developing and maintaining skills, and to ensure that adequate emergency response capabilities are maintained during the interval between evaluated exercises. Periodic drills are conducted for all five emergency teams (one per year for each team) involving a combination of some of the principal functional areas of the organization's onsite emergency response capabilities. Participants have the opportunity to consider accident management strategies, supervised instruction are permitted, and to resolve problems (success paths) rather than have controllers intervene. Communications drills are organized monthly to test the readiness of the members of the emergency response team on duty, of the communications network between the plant and state and county governments within the ten-mile emergency planning zone and the NRC. Communications between the plant, federal emergency response organizations, and states within the 50-mile EPZ are tested quarterly; while communications between the plant and state and local emergency operation centers and field assessment teams are conducted annually. Fire drills are conducted in accordance with the Fire Protection Programme. Medical emergency drills involving a simulated contaminated individual are conducted annually. Radiological monitoring drills are conducted annually, these drills include collection of the appropriate sample media both on site and off site as the drill scenario requires. In-plant radiation protection drills, including response to and analysis of simulated elevated airborne and liquid samples and direct radiation measurements are conducted every six months. Augmentation drills requiring travel to the site are conducted once every 24 months. Severe Accident Management Guideline table-top and/or inter-facility mini-drills are conducted periodically and involve a combination of some of the principal functional areas of the organization's onsite emergency response capabilities. The drills are evaluated by a drill observer. The degree of participation by outside agencies in conducting these drills may vary and their action may actually be simulated. Any state or local government located within the plume exposure pathway emergency planning zone will be allowed to participate in the drills when requested by such State or local government.

An emergency exercise aiming at testing the integrated capability of major response organizations is conducted once every two calendar years and it is based on a scenario

which is ultimately declared at least as a Site Area Emergency and it covers all main activities of the plant's emergency response organization. The scenario are varied from exercise to exercise such that all elements of the plant, county, and state plans and emergency organizations are tested within a 6-year period. Each organization should make provisions to start an exercise between 6:00 p.m. and 4:00 a.m. Every sixth year, the exercise is expanded to allow involvement of the federal response organizations in addition to the state and local organizations. Advance knowledge of the scenarios and the times of the exercises are kept to a minimum to ensure a realistic participation by those involved. Qualified observers from Progress Energy, Federal, State, or local governments will observe and critique each exercise.

During an emergency, the Brunswick Joint Information Center (JIC) is staffed with an integrated staff from the utility, State of North Carolina, county, and federal agencies such as the NRC and FEMA. The JIC is activated and staffed with utility personnel during each team training drill as part of the annual drill cycle. Frequent drill participation allows JIC personnel an opportunity to maintain the skills and knowledge essential to good performance during a real event, and increased opportunities to practice information exchange with the Emergency Operations Facility (EOF) at the site. State and county personnel participate with the utility at the JIC during the biennial NRC/FEMA evaluated exercises. In addition, state/county public information personnel are trained on JIC operations and process changes on an annual basis. The drills/exercises at the JIC include participation of individuals assigned as "mock general public" who make calls to the JIC rumor control staff with questions concerning the event; and "mock media" who attend press conferences and ask questions to gain insight into the cause of the emergency, offsite effects, etc. Interfacing with mock media and general public during drills/exercises provides the rumor control staff and individuals assigned as company spokesperson and technical spokesperson additional training on communications/interface with the public and news media during an actual event.

The emergency preparedness supervisor determines the corrective actions necessary and the schedules for performing them and evaluates the corrective actions taken. The tracking of corrective actions is made in the frame of the plant 'Corrective Action Tracking System'.

## DEFINITIONS

### DEFINITIONS – OSART MISSION

#### Recommendation

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

#### Suggestion

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

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

#### Good Practice

A good practice is an outstanding and proven performance, programme, activity or equipment in use that contributes directly or indirectly to operational safety and sustained good performance. A good practice is markedly superior to that observed elsewhere, not just the 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 IAEA REFERENCES (BASIS)

### *Safety Standards*

**Safety Series No.110; The Safety of Nuclear Installations (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.120; Radiation Protection and the Safety of Radiation Sources: (Safety Fundamentals)**

**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 Plants (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)**

**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-1.4; Building Competence in Radiation Protection and the Safe Use of Radiation Sources (Safety Guide)**

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

***INSAG, Safety Report Series***

**INSAG-4; Safety Culture**

**INSAG-10; Defence in Depth in Nuclear Safety**

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

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

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

**INSAG-15; Key Practical Issues In Strengthening Safety Culture**

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

**INSAG-17; Independence in Regulatory Decision Making**

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

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

**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**

***TECDOCs and IAEA Services Series***

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

**TECDOC-744; OSART Guidelines 1994 Edition**

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

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

**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**

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