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Annual Canadian Nuclear Safety Commission Staff Report for 2005 on the Safety Performance of the Canadian Nuclear Power Industry

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TABLE OF CONTENTS

SUMMARY

This report summarizes the Canadian Nuclear Safety *Commission* (CNSC) staff's assessment of the Canadian nuclear power industry's safety performance in 2005. The report describes the licensees' programs and implementation in nine safety areas. The report is intended to serve as a "mid-term report" for the Pickering B station, which is currently in the middle of the five-year period covered by its operating licence.

In addition to the assessment of the safety areas and programs for each station, the report makes comparisons between stations, shows year-to-year trends, and highlights significant issues that pertain to the industry at large.

CNSC staff observed, through inspections and reviews, that the power reactor industry operated safely in 2005. No worker at any power reactor station or member of the public received a radiation dose in excess of the regulatory limits. Emissions from all plants were also below regulatory limits. Safe operation of the industry in 2005 was also confirmed through the assessment of the Operating Performance safety area. The assessment of the other eight safety areas confirmed that, in general, the stations had adequate programs in place to support ongoing safe operation. Various performance indicators provided further evidence for these conclusions.

Most safety areas met the expectations of CNSC staff in 2005. As in previous years, the industry continued to have well-developed and well-implemented programs for the Emergency Preparedness, Environmental Protection, and Safeguards safety areas. With the improvements at Gentilly-2 under Radiation Protection in 2005, that safety area was also a noteworthy strength for the entire industry.

There were significant developments in 2005 in the Performance Assurance safety area. Progress was made at Darlington and Pickering A and B, where all the programs under the safety area, and their implementation, now meet CNSC expectations. However, more work remains before all the programs under Performance Assurance can meet requirements and be adequately implemented at Bruce A and B, Gentilly-2, and Point Lepreau.

INTRODUCTION

To meet the legal requirements of the Nuclear Safety and Control Act (NSCA) and Regulations, licensees must implement programs that provide adequate provisions for the protection of the environment, the health and safety of persons, the maintenance of national security, and the measures required to implement Canada's international obligations.

This report summarizes the Canadian Nuclear Safety *Commission* (CNSC) staff's assessment of the safety performance of nuclear power plant licensees in the Canadian nuclear power industry in 2005. The assessment is aligned with the legal requirements of the NSCA and Regulations, as well as the conditions of operating licences and applicable standards. Licensee programs are grouped into nine safety areas, and the design of the programs and their implementation and performance are assessed. General descriptions of the safety areas and their constituent programs are provided in the next section.

The conclusions in this report are supported by information gathered through CNSC staff inspections, general surveillance, document and event reviews, and performance indicators.

Section 1 of the report focuses on individual power reactor sites and provides detailed assessments of the safety areas and programs, highlighting areas where programs or performance fell below CNSC staff expectations. The Pickering B station is currently in the middle of the five-year period covered by its operating licence. Since this report is intended to serve as a "mid-term report" for Pickering B, additional details and a brief conclusion specific to Pickering B are provided.

Section 2 makes comparisons between stations, shows year-to-year trends, and highlights significant issues that pertain to the industry at large. It also contains tables of PI data and tables that summarize the grades for the licensees in 2005.

Some specialized and technical terms are defined in Appendix A and are italicized throughout the text. The acronyms used in this document are listed in Appendix B, and the grades assigned for each program and safety area are based on the rating system described in Appendix C.

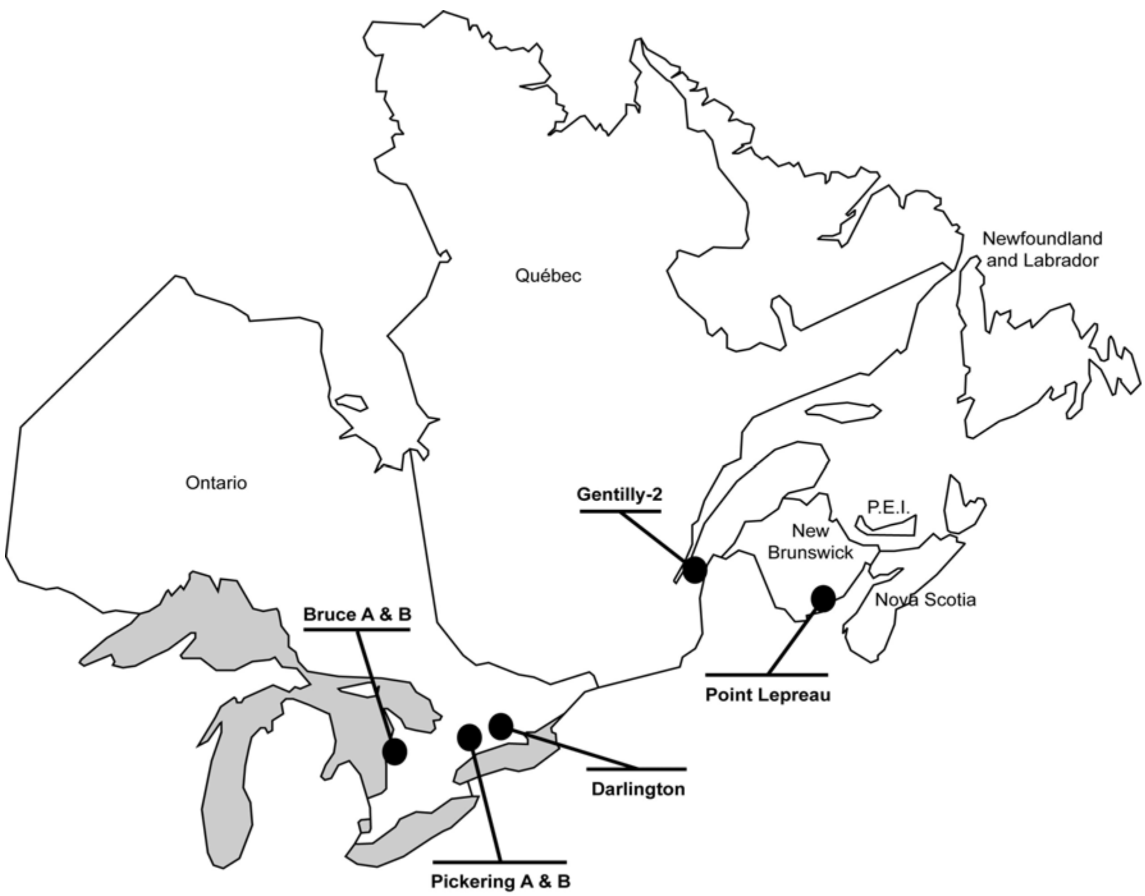
Important events or developments at the licensed sites in 2005 were reported to the *Commission* via *Commission Member Documents* (CMD) called Significant Development Reports (SDR). Appendix D, which is based on the SDRs, describes the significant developments relevant to power reactors in 2005 and follow-up activities.

Appendix E describes the current status of the generic action items (GAI) related to each licensee.

Finally, Appendix F is the French translation of Section 1.5, which pertains specifically to the assessment of the safety areas and safety performance at Gentilly-2.

Figure 1 shows the location of all power reactor sites in Canada, the number and generating capacity of the reactors, their initial start-up date, the names of the licence holders, and the expiry dates of current licences. Of the 22 CANDU reactors with operating licences issued by the *Commission*, 18 provided power to the electrical grid in 2005. In 2005, Ontario Power Generation announced that Units 2 and 3 at Pickering A, which are presently in a long-term, *lay-up state* will be de-fuelled, de-watered and placed in a safe storage state until the station is decommissioned. Bruce A Units 1 and 2 remain de-fuelled in a *lay-up state*.

Figure 1: Locations and Data for Nuclear Power Plants in Canada



PLANT DATA							
Plant	Bruce A	Bruce B	Darlington	Pickering A	Pickering B	Gentilly- 2	Point Lepreau
Licensee	Bruce Power	Bruce Power	Ontario Power Generation	Ontario Power Generation	Ontario Power Generation	Hydro-Québec	New Brunswick Power Nuclear
Reactor Units	4	4	4	4	4	1	1
Gross Electrical Capacity/Reactor (MW)	904	915	935	542	540	675	680
Start-Up	1976	1984	1989	1971	1982	1982	1982
Licence Expiry	2009/03/31	2009/03/31	2008/02/29	2010/06/30	2008/06/30	2006/12/31	2006/06/30

DEFINITIONS OF SAFETY AREAS AND PROGRAMS

Operating Performance

Operating Performance relates to organization and plant management and station operation. Operating Performance is a “cross-cutting” safety area that takes into account findings from all safety areas that are applicable to the overall performance of the plant, such as safety culture and review of the reactor transients. This safety area also includes non-radiological occupational health and safety.

Organization and Plant Management

Organization and Plant Management relates to the overall review of plant operation. This program covers high-level review topics and information from individual programs applicable to overall performance, as well as topics that fall under the direct responsibility of plant management.

Operations

The Operations program relates to the performance of the plant operating staff. It covers activities that operators perform to demonstrate the safe operation of plant systems and awareness of the “cool, control and contain” philosophy. The program covers licensees’ programs for operational inspections, procedural adherence, communications, approvals, change control and outage management. To verify these programs, CNSC staff carries out document reviews and field inspections of systems and operational practices. Also, CNSC staff monitors maintenance outages to ensure reactor safety principles are maintained, and licensees’ programs such as maintenance, radiation protection and dose control are effectively managed.

Occupational Health and Safety (Non-radiological)

Occupational Health and Safety is the program that both employers and workers must implement to ensure that the risk posed by conventional hazards in the plant is minimized.

Performance Assurance

Performance Assurance relates to the organization's policies and programs and their impact on the level of quality and safety. Quality Management, Human Factors and Training, Examination, and Certification are cross-cutting programs, meaning that performance in these programs affects the performance in other programs and the effectiveness of overall plant management processes. CNSC staff rates this safety area through the assessment of the development, implementation, and continuous improvement of policies, standards, and procedures required to manage licensee programs.

Quality Management

Quality Management is the program of coordinated activities to direct and control an organization with regard to quality and safety. It focuses on the achievement of results, in relation to the quality objectives, to satisfy the needs, expectations and requirements of interested parties as appropriate. An operational Quality Management program requires the series of processes necessary for the safe operation of the plant to be integrated and documented in manuals, policies, standards, and procedures.

Human Factors

Human Factors programs are intended to reduce the likelihood of human error by addressing factors that may affect human performance. The following are the human factors areas that are currently reviewed by CNSC staff to ensure licensees' compliance with regulatory expectations: human factors in design, work organization and job design (e.g. staffing levels, hours of work), human factors aspects of operating experience and *root-cause analysis*, human reliability, and usability aspects of procedures and job aids.

Training, Examination and Certification

The Training, Examination and Certification program ensures that there is a sufficient number of qualified workers to carry out the licensed activities. CNSC staff expects licensees to establish and implement adequate training programs to meet this requirement. These programs must provide licensee staff members in all relevant job areas with the necessary knowledge and skills to safely carry out their duties. Grades for Training, Examination and Certification are currently based on the review of training programs, using criteria based on the methodology called a *systematic approach to training*, and not the performance of licensee candidates in certification exams. However, ongoing satisfactory certification of workers is a requirement for all stations.

Design and Analysis

The Design and Analysis safety area relates to the activities that impact the ability of systems in a nuclear power plant to continually meet their design intent, given new information resulting from operating experience, safety analysis or the review of safety issues. When necessary, CNSC staff raises an *action item* with the licensee if a new failure or degradation mechanism is discovered. The licensee is then required to take interim compensatory measures to ensure that adequate safety margins of reactor operations are maintained. The issue is monitored until it has been satisfactorily and permanently resolved.

Safety Analysis

Safety Analysis relates to the confirmation that the probability and consequences of a range of design basis events are acceptable. Analysis results also define safe operational limits. Power reactor licensees routinely carry out safety analyses to confirm that changes in the plant design are such that the consequences from design basis accidents continue to meet the requirements of the CNSC. CNSC staff reviews safety analyses mainly to verify that they employ reasonably conservative assumptions, use validated models, have appropriate scope, and demonstrate acceptable results.

Safety Issues

Safety Issues relates to the identification and resolution of issues arising from research, incorporation of new knowledge, hazard analysis, or accident mitigation strategies.

A safety-related concern that cannot be resolved based on current knowledge is referred to as an outstanding safety issue. CNSC staff has formally documented those outstanding safety issues that are common to more than one station and complex in nature as generic action items (GAI). Further work, occasionally including experimental research, is required to more accurately determine the overall effect of a GAI on the safety of the facility. Nevertheless, CNSC staff judges that continued station operation is permissible because the majority of GAIs deal with situations where safety margins still exist but may be subject to potential degradation. Issues with confirmed, immediate safety significance are addressed by other means on a priority basis.

To ensure that CNSC expectations are clear for each GAI, CNSC staff has developed position statements that include closure criteria and an expected timeframe for closure.

Design

Design relates to the upkeep of the initial plant specifications to align with modern standards, improved practices, or correction of past deficiencies.

CNSC staff reviews plant design to ensure licensees maintain a documented description of equipment, including equipment qualification and classification requirements. CNSC staff reviews licensees’ design change and safety enhancement programs, as well as programs that impact on the overall safe operation of the plant, such as fire protection.

Equipment Fitness for Service

Equipment Fitness for Service includes those programs that impact on the physical condition of structures, systems and components (SSC) in the plant. This safety area covers Maintenance, Structural Integrity, Reliability, and Equipment Qualification programs. To ensure that safety-significant SSCs are effective and remain so as the plant ages, licensees must establish adequate *environmental qualification* (EQ) programs and integrate the results of inspection and reliability programs into their plant maintenance activities.

Maintenance

Licensees are required to maintain their SSCs in a state that conforms to the current design requirements and analysis results, and are required to implement a maintenance program that includes adequate organization, tools and procedures. Licensees must also demonstrate that related programs involving reliability, EQ, training, technical surveillance, procurement, and planning effectively support this maintenance program.

Structural Integrity

Structural Integrity relates to the periodic inspections of major components to ensure that they remain fit for service.

CNSC staff requires that licensees establish strategies to manage structural integrity problems, including monitoring, assessing, mitigating, and, if appropriate, replacing degraded components. Licensees carry out periodic inspections to confirm that major primary heat transport systems and safety system components—important to worker and public health and safety and the protection of the environment—remain fit for service. The emphasis of these inspections is on *pressure tubes*, *feeder* piping and *steam generator* tubes.

Reliability

Licensees must establish a program that includes setting reliability targets, performing reliability assessments, testing and monitoring, and reporting for plant systems whose failure impacts on the risk of a release of radioactive or hazardous material. CNSC staff reviews of licensees' reliability programs mainly cover:

- reliability models and data verification;
- safety system availability;
- testing program; and
- reporting.

Equipment Qualification

Equipment Qualification relates to plant-specific functional and performance requirements that ensure that SSCs are suitable for operation. An important part of the Equipment Qualification program is EQ. The purpose of EQ is to ensure the capability of equipment to perform its intended safety function in an aged condition and under extreme environmental conditions resulting from design basis accidents. To be deemed effective, the EQ programs must meet a number of acceptance criteria developed by CNSC staff. The licensees must:

a. have a documented EQ program and associated processes in place;
b. ensure that EQ processes and procedures meet recognized industry standards;
c. install (or replace) the required equipment and have evidence that it is qualified to perform its intended safety function;
d. have all EQ-related documentation available at the station;
e. develop a program to assess degradation and failures of qualified equipment during normal operation;
f. ensure that EQ-related processes comply with the station quality assurance program; and
g. train operations and maintenance staff on EQ principles and processes.

Other review topics under Equipment Qualification are chemistry control and fire protection.

Emergency Preparedness

Emergency Preparedness relates to the consolidated emergency plan and the emergency preparedness program, as well as the results of all emergency exercises.

To be able to respond effectively to an emergency, licensees must establish a consolidated emergency plan and an emergency preparedness program under that plan, and must ensure the response capability of their staff through simulated emergencies. To evaluate the emergency preparedness of a licensee, CNSC staff assesses the emergency plan and preparedness program, as well as the results of simulated emergency exercises. The assessment of the emergency plan provides an indication of the effectiveness of the emergency response strategy. The review of the emergency preparedness program verifies that all components of the emergency response plan are in place and maintained in a state of readiness. Finally, the evaluation of the facility's staff during a simulated nuclear accident provides an assessment of the emergency response capability.

Environmental Protection

Environmental Protection relates to the programs that identify, control and monitor all releases of radioactive and hazardous substances from facilities. This safety area includes effluent and environmental monitoring, emission data, and unplanned releases.

CNSC regulations require that each licensee take all reasonable precautions to protect the environment and to control the release of radioactive and hazardous substances. CNSC staff verifies that licensees have programs in place to identify, control and monitor all releases of nuclear and hazardous substances from their plants. CNSC staff reviews of Environmental Performance include:

- public dose;
- emission data;
- effluent and environmental monitoring; and
- unplanned releases.

Radiation Protection

Radiation Protection relates to the program in place to ensure protection of persons inside a nuclear facility from unnecessary exposure to ionizing radiation. The *Radiation Protection Regulations* prescribe dose limits for workers who may be exposed to radioactive material. In addition, one of the requirements in the regulations requires licensees to establish a radiation protection program with part of it devoted to keeping exposures to radiation as low as reasonably achievable (the ALARA principle) through the implementation of a number of control programs. These control programs include management control over work practices, personnel qualification and training, control of occupational and public exposures to radiation, planning for unusual situations, and verification of the quantity and concentration of any nuclear substance released as a result of the licensed activity.

Site Security

Site Security relates to the program required to implement and support the security requirements stipulated in the *Nuclear Security Regulations* and any site-specific orders.

To obtain assurance of compliance with these requirements, CNSC staff assesses licensees':

- security guard service, including duties, responsibilities and training;
- nuclear response force, including equipment, training and deployment;
- protection arrangements with off-site response forces and testing of response plans;
- procedures to assess and respond to potential breaches of security; and
- security monitoring, assessment, detection, communication, access control systems, hardware and software.

Licensees are required to have a sufficient number of trained and properly-equipped security staff available at all times. Their sites must be continuously monitored and licensees must take appropriate action in the event of a security breach. In addition, while not directly specified by the regulations, CNSC staff expects all licensees to conduct joint security exercises with their respective off-site response forces.

Safeguards

The CNSC's regulatory mandate includes ensuring conformity with measures required to implement Canada's international obligations under the Treaty on the Non-Proliferation of Nuclear Weapons. Pursuant to the Treaty, Canada has entered into a *safeguards* agreement with the *International Atomic Energy Agency* (IAEA). This agreement provides the IAEA with the right and the responsibility to verify that Canada is fulfilling its international commitment on the peaceful use of nuclear energy.

The CNSC provides the mechanism, through the Nuclear Safety ad Control Act and Regulations as well as licence conditions, for the IAEA to implement the *safeguards* agreement. Conditions for the application of IAEA *safeguards* are contained in power reactor operating licences. Compliance includes the timely provision of reports on activities and on the movement and location of all nuclear materials and also the provision of measures for the application of IAEA *safeguards*.

SECTION 1

SAFETY PERFORMANCE AT THE POWER REACTOR SITES

This section of the report is organized by power reactor site, with grades provided for safety areas and programs for each site. The grades for all sites are also summarized in the tables at the end of Section 2. The definitions of the safety areas and programs are provided in the preceding section.

The grades assigned for each program and safety area are based on the rating system defined in Appendix C. The grades are supported by information gathered through inspections by Canadian Nuclear Safety *Commission* (CNSC) staff, general surveillance, correspondence, and document and event reviews.

The sub-section for Pickering B also serves as a “mid-term report” for the current term of its operating licence. As such, that sub-section contains detailed discussions of programs and safety areas requiring attention from the licensee and presents brief conclusions.

1.1 BRUCE-A AND BRUCE-B

1.1.1 Operating Performance

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Bruce A	OPERATING PERFORMANCE	B	B
	Organization & Plant Management	B	B
	Operations	B	B
	Occupational Health & Safety (Non-radiological)	B	B
Bruce B	OPERATING PERFORMANCE	B	B
	Organization & Plant Management	B	B
	Operations	B	B
	Occupational Health & Safety (Non-radiological)	B	B

Both the program and implementation of the Operating Performance safety area at Bruce A and B met the expectations of Canadian Nuclear Safety *Commission* (CNSC) staff. The programs under the safety area contributed adequately to safe facility operation in 2005 and, in general, to the achievement of the CNSC's desired outcomes. Bruce A and B operated safely in 2005.

1.1.1.1 Organization and Plant Management

The management of Bruce Power continued to provide leadership to its staff and to promote safety in 2005. Bruce Power continued to improve integration of the Bruce site and its processes. In 2005, Bruce Power invited auditors from the World Association of Nuclear Operators to assess its performance.

During inspections at Bruce A and B in 2005, CNSC staff observed promotion of safety by the licensee's organization and good compliance with requirements. There were no *serious process failures* at Bruce A or B, and the operating transients were of minimal consequence.

In 2005, Bruce A had three reactor trips, no *stepbacks* and 22 *setbacks* (included in Table 1). The majority of the *setbacks* were minor in nature (less than 1% power change) and were due to a noisy signal on a flux detector channel. The situation was exacerbated by the installation of new, more sensitive sensors that resulted in a tighter margin to trip the channel. Bruce Power corrected the problem that caused the *setback*s and there was only one *setback* after the correction from July to the end of 2005.

In 2005, Bruce B had two reactor trips, three *stepbacks* and two *setbacks* (included in Table 1).

1.1.1.2 Operations

CNSC staff conducted several field and control room inspections to verify compliance during 2005, and no major findings were reported.

There were two planned outages at Bruce A in 2005—both in the spring. There were also two planned outages at Bruce B—one in the spring and one in the fall. Overall, the outage program and implementation at Bruce Power were satisfactory.

1.1.1.3 Occupational Health and Safety (Non-radiological)

The conventional safety record at Bruce Power reflects a strong conventional safety program, as well as strong safety culture, leadership, and continuous safety training. Bruce Power has an effective worker health and safety committee that is actively involved in plant operation. The value of the "Accident Severity Rate" performance indicator (PI) at Bruce A and B (0.9 in 2005) compared favourably with the rest of the industry (see Tables 9 and 10). Lost-time accidents at Bruce Power were at an all-time low. Strength in work protection was also observed during the *type II inspection* of the Unit 4 maintenance outage in 2005. Overall, the Occupational Health and Safety program and implementation met CNSC performance expectations.

1.1.2 Performance Assurance

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Bruce A	PERFORMANCE ASSURANCE	B	C
	Quality Management	C	C
	Human Factors	B	C
	Training, Examination, and Certification	B	C
Bruce B	PERFORMANCE ASSURANCE	B	B
	Quality Management	C	B
	Human Factors	B	C
	Training, Examination, and Certification	B	B

At Bruce A and B, the design of the programs in the Performance Assurance safety area met CNSC staff's overall expectations. At Bruce A, however, implementation of the safety area was considered to be below expectations because of a lack of adherence to some elements of those programs.

1.1.2.1 Quality Management

A major area of concern is the adequacy of Bruce Power's Quality Management system documentation. A revision of Section 6.4.3 of Bruce Power's management system manual was reviewed in 2005 and was determined to be acceptable. However, there are ongoing issues with

Bruce Power's project to realign and update its program documentation, which has been modified several times since 2003.

In December 2005, Bruce Power submitted a project execution plan for its Process and Document Enhancement Project to CNSC staff. Bruce Power reported that their management system manual, policies, and programs were completed, and that the revision of their procedures and work instructions was in progress. CNSC staff has not yet evaluated the documentation against the quality assurance requirements of the Canadian Standards Association (CSA) N286 series of standards. In the meantime, the Quality Management program for Bruce Power continues to be considered below requirements.

In 2005, CNSC inspections of Bruce Power indicated deficiencies in its documentation control process. The inspections identified a lack of appropriate cross links, inconsistencies between documents, and the use of uncontrolled documents for some processes. Despite the deficiencies, the implementation of Quality Management at Bruce B was considered to meet overall CNSC expectations.

The loss of reactor regulation event at Bruce A Unit 3 in 2005 (see Section D.1.3) was linked to a Quality Management performance deficiency. The event was partly caused by a design problem that remained uncorrected for a long period of time. In addition, licensee staff had created a "work-around" practice that did not adhere to the documented procedure. Implementation of the Quality Management program was ineffective in detecting or stopping the practice.

Based on the observations above, implementation of the Quality Management program for Bruce A was considered to be below expectations in 2005.

1.1.2.2 Human Factors

Based on compliance activities in 2005, Bruce Power had acceptable processes to support each Human Factors review area.

In 2005, a *type I inspection* at Bruce Power focused on compliance with operations, maintenance, and radiation protection procedures. During the inspection, CNSC staff found a backlog of procedural changes with no PIs or targets related to the number or timeliness of completion of many of the updates. Although procedural changes related to operations were prioritized based on risk, outstanding changes to maintenance procedures were not prioritized. In addition, CNSC staff found that Bruce Power was not monitoring the backlog of flow-sheet updates. Based on the above, implementation of the Human Factors program at Bruce A and B was considered to be below requirements. A positive aspect identified during the inspection was that Bruce Power self-identified issues with procedural use and adherence during an internal audit. Bruce Power was in the process of implementing several improvement initiatives at the time of the CNSC's inspection.

Section 2.2.2 describes the amendments to the licences of multi-unit stations in 2005 to formalize timeframes for ensuring an Authorized Nuclear Operator (ANO) is at the reactor unit's main control room panels at all times. Due to staffing constraints, Bruce A is not able to meet this requirement with two reactor units in operation until 2009. A shortage of certified shift personnel has persisted at Bruce A since the restart of Units 3 and 4. Staffing constraints at Bruce A will be closely monitored by CNSC staff during the anticipated restart of Units 1 and 2.

In 2005, Bruce Power had a plan to guide the station's efforts to improve human performance. Key areas of focus were pre-job briefings and post-job debriefings, procedural use and adherence, and three-way communication. Activities included the use of human performance simulators to reinforce expected behaviours and the use of critical task analysis to identify error-likely tasks.

1.1.2.3 Training, Examination, and Certification

There were no evaluations of training programs conducted at Bruce A in 2005. At Bruce B, the station-specific initial training program for ANOs was evaluated. Although six deficiencies were identified, overall, this training program met the expectations of CNSC staff.

During 2005, the success rate of shift supervisor and reactor operator candidates in CNSC examinations at Bruce A and Bruce B was adequate. Progress was made by Bruce Power toward fulfilling its commitments for establishing training programs for certified shift personnel that are in accordance with the principles of a *systematic approach to training*, as required by conditions in its operating licences. At Bruce A, the schedule for completing the establishment of those programs significantly slipped during 2005.

In anticipation of the increased demand for certified shift personnel for the restart of Bruce A Units 1 and 2, a second "reactor unit" is being constructed at the Bruce A full-scope simulator. This addition will significantly increase the simulator time available for training and testing.

A new licence condition was added to the Bruce A operating licence in April 2004 to specify that written and simulator-based requalification tests must be completed by certified shift personnel during the term of their certification. During 2005, Bruce Power piloted relevant written and simulator-based requalification tests at Bruce A, but there was no official requalification testing. In December 2005, Bruce Power requested a licence amendment to allow for the official implementation of the requalification testing program to be delayed until January 1, 2006. The primary reason for the delay of almost two years was the shortage of certified shift personnel available to the Bruce A training department to establish the program. (Instead, the first priority at Bruce A was the delivery of the initial certification training programs needed to ensure that the minimum shift complement requirements for certified shift personnel can be reached and maintained at Units 3 and 4.)

In June 2005, CNSC staff conducted an evaluation of requalification testing at Bruce B involving comprehensive simulator-based tests (CST) designed to test a number of certified individuals in a control room team environment. CNSC staff found that the Bruce Power procedure to develop and administer CSTs contained rules for assigning critical and significant errors to certified individuals during requalification tests that were different from the rules in the governing document referenced in the Bruce A and B operating licences. In November 2005, CNSC staff observed one CST conducted as part of the pilot implementation of the requalification testing program at Bruce A. CNSC staff concluded that the changes made by Bruce Power to the rules used for assigning critical and significant errors were bringing into question the reliability and validity of the results of the CSTs conducted at Bruce A and Bruce B to demonstrate that ANOs, Control Room Shift Supervisors, and Shift Managers have retained the knowledge and skills required to work competently in their assigned positions. Bruce Power was requested to revise its procedure and take corrective action to address the situation. These activities were completed to the satisfaction of CNSC staff.

Although deficiencies were found in the requalification testing program, overall, the Training, Examination and Certification programs at Bruce A and B met the requirements of the CNSC. The implementation of the Training, Examination and Certification program met the requirements of the CNSC at Bruce B, but, due to the lack of progress of requalification testing, implementation is now considered to be below expectations at Bruce A.

1.1.3 Design and Analysis

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Bruce A	DESIGN AND ANALYSIS	B	B
	Safety Analysis	B	B
	Safety Issues	B	B
	Design	B	C
Bruce B	DESIGN AND ANALYSIS	B	B
	Safety Analysis	B	B
	Safety Issues	B	B
	Design	B	B

Both the program and implementation of the Design and Analysis safety area at Bruce A and B met CNSC staff's expectations. The programs under the safety area contributed adequately to safe facility operation in 2005 and, in general, to the achievement of the CNSC's desired outcomes. CNSC staff reviews concluded that the licensee continued to provide acceptable safety analyses and responses to new design and safety issues.

1.1.3.1 Safety Analysis

CNSC staff reviews confirmed that Bruce Power performed acceptable safety analysis in 2005 and made adequate progress toward updating its safety report. Bruce Power's funding of research programs and its monitoring and assessment of new information and research findings to ensure the validity of the safety analysis were considered satisfactory.

In 2005, Bruce Power submitted safety analysis in support of the use of low void reactivity fuel in a Bruce B unit for the demonstration irradiation phase. CNSC staff found the analysis to be acceptable.

1.1.3.2 Safety Issues

CNSC staff reviewed the progress made by the various industry teams to resolve the generic action items (GAIs). Bruce Power continued to participate on the teams and the overall progress toward resolution of the GAIs was satisfactory. For more details on particular safety issues, see Appendix E for developments in each GAI in 2005.

1.1.3.3 Design

Bruce Power's documentation of equipment qualification and equipment classification was judged to be adequate in 2005. No deficiencies with respect to design changes were identified and the licensee continued to pursue safety enhancement programs.

An unscheduled *type II inspection* of fire protection was conducted at Bruce A to review combustible loading and transient combustible material control (see Section D.1.1). The inspection findings indicated poor housekeeping practices, unacceptably high levels of combustible loading, and the storage of combustible materials in inappropriate locations, particularly in Units 1 & 2. The inspection observations contravened the requirements of the National Fire Code of Canada and CSA N293-95 ("Fire Protection for CANDU Nuclear Power Plants"), as referenced in the operating licence. Seven directives and two action notices were issued based upon the findings of the inspection. Because of this significant weakness in fire protection, implementation of the Design program was judged to be below requirements. Improvements have been noted in subsequent inspections.

1.1.4 Equipment Fitness for Service

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Bruce A	EQUIPMENT FITNESS FOR SERVICE	B	B
	Maintenance	B	C
	Structural Integrity	B	B
	Reliability	B	B
	Equipment Qualification	B	B
Bruce B	EQUIPMENT FITNESS FOR SERVICE	B	B
	Maintenance	B	B
	Structural Integrity	B	B
	Reliability	B	B
	Equipment Qualification	B	B

The Bruce A and B programs in the Equipment Fitness for Service safety area, and their implementation, met CNSC staff's expectations and contributed to the achievement of safe facility operation in 2005. However, the implementation of the Maintenance program at Bruce A was below requirements.

1.1.4.1 Maintenance

Bruce Power has policies, processes and procedures in place that provide direction and support for its maintenance program. Bruce Power issued a new management system process model that includes core processes and sub-tier processes that are designed to meet the needs of its maintenance program. CNSC staff continues to monitor the implementation of the new processes and procedures.

A *type II inspection* of the Bruce A maintenance program revealed that the corrective maintenance backlog was above Bruce Power's target. The weekly task completion rate at Bruce A was consistently below Bruce Power's target in 2005, and this issue was reflected in some system health reports. Several missed mandatory relief valve tests were reported in 2005. Bruce Power has developed processes and procedures for planning and backlog reduction.

These observations indicate that implementation of the Bruce A maintenance program is below performance expectations. Adequately implemented corrective actions are necessary for the licensee to meet expectations.

1.1.4.2 Structural Integrity

Since September 2003, five inspection reports were submitted for planned periodic inspection campaigns, some of which were up to three years late. Bruce B completed an extensive review of its compliance with CSA pressure boundary requirements. Numerous shortfalls were identified and 53 corrective actions were required (see Section D.2.4 for more details). In September 2005, a *type II inspection* found that Bruce Power had improved the control of the Bruce A periodic inspection programs.

Pressure tube (PT) elongation has been identified by Bruce Power as a life-limiting concern for Unit 3. If left unchecked, the elongation could result in the end supports of PTs travelling beyond the bearings for a number of fuel channels before their intended end of life. Since operation in this mode has not been demonstrated to be acceptable, Bruce Power committed to not operate any fuel channels in an "off-bearing" condition without prior CNSC approval. As a preventive measure, Bruce Power initiated a selective de-fuelling program to lessen PT elongation.

In 2005, Bruce Power inspected *feeder* pipe wall thinning in Unit 3. Based on the measurements, the licensee concluded that the wall thickness of all Unit 3 *feeders* will remain above the minimum required thickness beyond the next planned *feeder* pipe inspection outage.

Inspections of *steam generators* (SG) in Bruce Units 3, 4, 5 and 7 were completed. The main types of degradations that were detected were fretting of SG and pre-heater tubes and pit-like indications on the outside diameter of pre-heater tubes. CNSC staff considers that Bruce Power's inspection capabilities are adequate to manage these types of degradation in the short term, and that Bruce Power has demonstrated that the Unit 3 and 4 SGs can safely continue operation.

1.1.4.3 Reliability

In 2005, Bruce Power continued to implement the requirements in the new regulatory standard S-98 (Reliability Programs for Nuclear Power Plants). By the end of March 2006, Bruce Power planned to complete the unavailability models of the systems important to safety and finalize the governance documents associated with the reliability program.

In 2005, CNSC staff conducted a *type I inspection* on station reliability records and data handling processes. The inspection indicated that the process to collect and treat reliability data, data handling training, and the computer software do not meet CNSC expectations. Bruce Power is working on the necessary corrective actions. In the meantime, the likelihood of reliability data collection and treatment falling significantly below requirements in the short term remains low due to the diligence of the reliability specialists.

Bruce Power's systems that are important to safety performed well in 2005, in terms of reliability, with the exception of shutdown system (SDS) #2 at Bruce A. Bruce Power identified *environmental qualification* (EQ) non-compliances that could have affected the ability of SDS #2 at Bruce A to function following a steam-line break event. See Section 1.1.4.4 for more details.

Bruce A Unit 3 experienced a loss of regulation in 2005 that revealed, among other things, a lack of an aging management strategy for transmitters. The licensee completed a series of corrective actions and committed to implement additional actions. CNSC staff is monitoring the licensee's progress (see section D.1.3 for more details).

The review of the Bruce A probabilistic risk assessment (PRA) continued in 2005. So far, the review has revealed no concerns (e.g., major weaknesses of the plant design or operation) that required attention. The study complied, in general, with the intent of CNSC regulatory standard S-294 ("Probabilistic Safety Assessment [PSA] for Nuclear Power Plants"), which was issued in 2005. However, there are specific requirements in S-294 regarding common cause failures and uncertainty modeling that need to be addressed. Bruce Power is addressing the recommendations of CNSC staff that resulted from the initial review. Based on results of the Bruce A PRA, Bruce Power has already made progress in developing preliminary unavailability models for systems important to safety. Other updates of the PRA are ongoing and preparations are underway for its use in decision-making processes.

1.1.4.4 Equipment Qualification

A CNSC inspection of the Bruce A EQ program determined that the program and its implementation met the intent of the CNSC's acceptance criteria.

In 2005, Bruce A found that the steam protection in two rooms containing SDS #2 equipment deteriorated to the point that there was no assurance that the design requirements could be met. The deterioration had an adverse effect on the availability of SDS #2, but the exact effect is difficult to quantify. The degradation occurred over a period as long as four months. Also, in a typical postulated mission of the SDS #2, such as a high-energy line break, it is very likely that SDS #2 will activate before the steam reaches the aforementioned rooms.

Root-cause analysis performed by Bruce Power revealed a number of contributing factors, including 1) lack of knowledge and understanding of the steam protection requirements by licensee staff, and 2) less-than-adequate implementation of the steam protection barrier program.

1.1.5 Emergency Preparedness

Site	SAFETY AREA	Grades	
		Program	Implementation
Bruce A	EMERGENCY PREPAREDNESS	A	A
Bruce B	EMERGENCY PREPAREDNESS	A	A

From the observation of a corporate site exercise at Bruce A, the inspection team concluded that Bruce Power demonstrated its preparedness and competence in dealing with a simulated accident, adequate exchange of information at the local level, and aptitude in decision making.

The Emergency Preparedness program at Bruce B is analogous to that at Bruce A. CNSC staff did not identify any changes suggesting any degradation in the program or weaknesses in its implementation. Program and implementation at Bruce A and B are judged to exceed expectations.

1.1.6 Environmental Protection

Site	SAFETY AREA	Grades	
		Program	Implementation
Bruce A	ENVIRONMENTAL PROTECTION	B	B
Bruce B	ENVIRONMENTAL PROTECTION	B	B

The Environmental Protection program and its implementation at Bruce A and B met CNSC expectations in 2005. Both airborne emissions and liquid releases of nuclear substances to the environment were below the *derived release limits* for Bruce A and B. Therefore, estimated radiation doses to the public were well below the regulatory limits. There were no unplanned releases of nuclear substances or hazardous substances from Bruce A and B that posed an unreasonable risk to the environment. There was one noteworthy conventional spill from the transformer of Bruce B Unit 6. However, the spill had no significant environmental impact—see Section D.2.2 for details.

1.1.7 Radiation Protection

Site	SAFETY AREA	Grades	
		Program	Implementation
Bruce A	RADIATION PROTECTION	B	B
Bruce B	RADIATION PROTECTION	B	B

In 2005, expanded outage scope increased the occupational exposure at Bruce A and B, but the doses remained as planned. Unplanned outages, however, contributed additional doses. The total, collective dose for the site doubled from 416 to 832 person-rems for six reactors from 2004 to 2005. However, no worker received doses in excess of the regulatory limits in 2005.

CNSC staff observed improvements in the outage radiation dose with teledosimetry and improved procedural compliance. CNSC staff observed that electronic personal dosimeter alarms are now rigorously observed and follow-up is conducted for all reported personal contamination events.

At Bruce A, CNSC staff observed persisting problems of airborne tritium, partly due to problems with the vault vapour recovery driers. At Bruce B, CNSC staff observed better control of airborne tritium during outages.

The respiratory protection program at Bruce A and B continued to be well implemented in 2005. Progress in the areas of contamination control, ALARA (as low as reasonably achievable) planning and dose control, and radiation protection training were also observed.

1.1.8 Site Security

The assessment of the Site Security safety area for Bruce A and B is documented in a separate (secret) *Commission Member Document* (CMD 06-M35.A).

1.1.9 Safeguards

Site	SAFETY AREA	Grades	
		Program	Implementation
Bruce A	SAFEGUARDS	B	B
Bruce B	SAFEGUARDS	B	B

In 2005, programs at Bruce A and B to help fulfil Canada's obligations with respect to international *safeguards* met the applicable legal requirements and CNSC staff's expectations.

1.2 DARLINGTON

1.2.1 Operating Performance

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Darlington	OPERATING PERFORMANCE	B	B
	Organization & Plant Management	B	B
	Operations	B	B
	Occupational Health & Safety (Non-radiological)	B	B

Both the program and implementation of the Operating Performance safety area at Darlington met the expectations of Canadian Nuclear Safety *Commission* (CNSC) staff. The programs under the safety area contributed adequately to safe facility operation in 2005 and, in general, to the achievement of CNSC's desired outcomes. Darlington operated safely in 2005.

1.2.1.1 Organization and Plant Management

There were two significant events at Darlington in 2005 related to process failures. The first involved a partial loss of low-pressure service water in Unit 1 due to the fouling of one strainer that led to the rapid fouling of two other strainers (the fourth strainer was out of service for maintenance). This resulted in excessively low pressure in the service water downstream of the strainers. Ontario Power Generation (OPG) addressed the problem with a corrective action plan that included changes to maintenance, procedures, and low-pressure set points.

The second event involved the initiation of a controlled shutdown of Unit 1 in September 2005, when operational staff was working to restore the circulating cooling water screen-wash system. OPG is currently performing an "apparent cause" investigation of the event.

Darlington experienced four unplanned transients in 2005 involving reactor power reduction—this included one manual shutdown, one *stepback*, and two *setbacks*, as reported in Table 1.

CNSC staff is concerned about equipment aging at Darlington. There have been some component failures that were caused by age-related degradation mechanisms, as well as *feeder* thinning (see Section 1.2.4.2) and piping support problems. CNSC staff judges that Darlington's control of plant status and material condition was adequate in 2005. OPG has a program in place to monitor the condition of various components (including inspection strategies for fuel channels, *feeders*, and *steam generators* (SG)), as outlined in its life cycle management plan and system health reports.

1.2.1.2 Operations

CNSC staff conducted several field and control room inspections during 2005; no major findings were reported.

Darlington currently implements a planned outage cycle for each unit that involves two outages every four years. OPG plans to change this arrangement to one longer outage every three years, which will increase maintenance periods for each unit. OPG believes this will improve station safety and reliability. CNSC staff is currently reviewing these plans to confirm their acceptability according to various safety requirements. Overall, CNSC staff considered the outage program at Darlington and its implementation to be satisfactory in 2005.

1.2.1.3 Occupational Health and Safety (Non-Radiological)

Although three injuries were reported at Darlington in 2005, none of the injuries were significant. The review of the "Accident Severity Rate" performance indicator data in 2005 revealed no significant findings. The value of the PI at Darlington (1.0 in 2005) compared favourably with the rest of the industry (see Tables 9 and 10).

In 2005, OPG addressed the *action notices* associated with the *type II inspection* in 2004 to evaluate the implementation of the Work Protection Code at Darlington. Overall, the Occupational Health and Safety program and implementation met CNSC performance expectations.

1.2.2 Performance Assurance

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Darlington	PERFORMANCE ASSURANCE	B	B
	Quality Management	B	B
	Human Factors	B	B
	Training, Examination, and Certification	B	B

Both the program and implementation of the Performance Assurance safety area at Darlington met CNSC staff's expectations. The programs under the safety area contributed adequately to safe facility operation in 2005 and, in general, to the achievement of CNSC's desired outcomes.

1.2.2.1 Quality Management

In 2005, OPG took corrective action to improve its procedure governing self-assessments to correct discrepancies related to management oversight and leadership.

Inadequate documentation contributed to events in 2005 involving a partial loss of low-pressure service water (see Section 1.2.1.1) and a high temperature at the outlet of the shutdown cooling system. A *type I inspection* raised a concern regarding procedure content and length of revision time, however, no problems were evident with the documentation control process itself.

Three events in 2005 involved deviation from procedures: 1) non-adherence to calibration schedule requirements, 2) unavailability of valve vendor documentation on file, and 3) failure to obtain CNSC permission before continuing work. However, no trend of procedural non-compliance was evident.

1.2.2.2 Human Factors

Based on the results of compliance activities carried out in 2005, Darlington met the CNSC's expectations for the Human Factors program and its implementation.

In 2005, OPG developed a corrective action plan to address the weaknesses identified in Darlington's system for ensuring that minimum shift complement staff members have all the required qualifications. In December 2005, CNSC staff inspected OPG to verify that it had systems to ensure compliance with minimum shift complement and hours of work requirements. During the inspection, CNSC staff determined that the implementation of several of Darlington's corrective actions was behind schedule. CNSC staff continues to monitor the adequacy of Darlington's staffing levels and the status of corrective actions related to minimum shift complement staffing.

CNSC staff carried out a procedural compliance inspection at Darlington in 2005 and found that processes to support procedural compliance at Darlington were satisfactory.

CNSC staff also conducted an inspection of Darlington's Work Protection Code implementation near the end of 2004. Darlington provided acceptable corrective action plans to address the issues raised in 2005, but the work necessary to close the action notices, which requires modifying the Work Protection Code procedure, is not yet complete.

Section 2.2.2 describes licence amendments made in 2005 for Darlington to formalize timeframes for improvements in certified staffing.

The human performance initiatives at Darlington in 2005 were procedure use and adherence, event-free operation, and safety culture. Regular updates on the implementation of the plans to meet the targets were provided at oversight meetings. OPG assigned management accountability for the specific human performance initiatives and targets.

1.2.2.3 Training, Examination, and Certification

Four certified staff training programs were evaluated at Darlington in 2005:

- initial simulator training program for Authorized Nuclear Operators (ANO);
- simulator training program for Unit 0 Control Room Operators;
- incremental training program for Shift Managers/Control Room Shift Supervisors; and
- simulator training program for Shift Managers/Control Room Shift Supervisors.

No evaluations of the requalification testing program were conducted at Darlington in 2005.

CNSC staff continued the ongoing review of Darlington's incorporation of its station-specific program objectives into the initial training program for ANOs and the initial training program for Unit 0 Control Room Operators. This OPG initiative is resource-intensive and is currently on schedule to meet its target completion date in 2006.

In 2005, one entire class of Shift Supervisor candidates failed the Darlington in-house simulator examination. This postponed the CNSC Shift Supervisor certification simulator examination for this class until early 2006.

Although evaluations conducted during 2005 identified some deficiencies, progress was made by Darlington to fulfill its corrective action commitments in the training programs for certified and non-certified staff and the requalification testing program. The success rate in certification examinations at Darlington was adequate.

1.2.3 Design and Analysis

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Darlington	DESIGN AND ANALYSIS	B	B
	Safety Analysis	B	B
	Safety Issues	B	B
	Design	B	B

Both the program and implementation of the Design and Analysis safety area at Darlington met CNSC staff's expectations. The programs under the safety area contributed adequately to safe facility operation in 2005 and, in general, to the achievement of the CNSC's desired outcomes. CNSC staff reviews concluded that the licensee continued to provide acceptable safety analyses and responses to new design and safety issues.

1.2.3.1 Safety Analysis

CNSC staff reviews confirmed that Darlington performed acceptable safety analysis in 2005 and made adequate progress toward updating its safety report. OPG's funding of research programs and its monitoring and assessment of new information and research findings to ensure the validity of Darlington's safety analysis were considered satisfactory.

1.2.3.2 Safety Issues

CNSC staff reviewed the progress made by the various industry teams to resolve the generic action items (GAI). OPG continued to participate on the teams and the overall progress toward resolution of the GAIs was satisfactory. For more details on particular safety issues, see Appendix E for developments in each GAI in 2005.

1.2.3.3 Design

The flow measurement degradation project at Darlington was initiated in 2000 to address observed degradation in the shutdown system (SDS) flow measurements. Darlington determined the *root cause* of the problem and proposed a mitigating strategy to confirm the actual flow using an alternative flow measurement method. In 2005, Darlington provided adequate status updates and information about the planned calibration of the SDS #2 flow transmitter for Unit 2.

CNSC staff reviewed selected documents relating to the implementation of Darlington's fire protection program in 2005. Reviews and assessments of event reports and individual documents indicated no major weaknesses in the implementation of the program.

1.2.4 Equipment Fitness for Service

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Darlington	EQUIPMENT FITNESS FOR SERVICE	B	B
	Maintenance	B	B
	Structural Integrity	B	B
	Reliability	B	B
	Equipment Qualification	B	C

Both the program and implementation of the Equipment Fitness for Service safety area at Darlington met CNSC staff's expectations and contributed adequately to safe facility operation and the achievement of the CNSC's desired outcomes in 2005. However, both the *environmental qualification* (EQ) and Maintenance programs continued to concern CNSC staff. In 2005, the Darlington Maintenance program implementation showed some improvement, but a large maintenance backlog remained despite the progress made to reduce it. The completion of outstanding maintenance activities in a reasonable timeframe is essential to prevent the degradation of the equipment beyond acceptable limits. CNSC staff is also concerned about OPG staff's awareness of the EQ program. The lack of integration between EQ requirements and supporting documentation with the safety requirements (identified in the operational safety requirements documentation), is a recent issue in which a resolution may impact all of OPG's EQ programs. The long term sustainability of the EQ program remained a concern.

1.2.4.1 Maintenance

OPG had processes and procedures in place that provided direction and support for its Maintenance program. They contributed positively to the overall effectiveness of the Maintenance program at Darlington in 2005. However, there was no overall policy document integrating the sub-tier Maintenance program documents.

There was a very large number of outstanding maintenance activities at Darlington throughout 2005. OPG has taken this issue seriously and has indicated how the outstanding work is being managed and the backlogs reduced. Even so, CNSC staff remains concerned with the backlog at

Darlington and has requested backlog targets and a projection of when the targets will be met. If OPG does not continue to be diligent, there is potential for increased risk.

Darlington has processes and procedures for the surveillance and inspection of systems, structures, and components. Several CNSC inspections in 2005 indicated that surveillance and inspection programs were properly implemented. Although Darlington has processes and procedures for plant life management, the implementation of that program is not yet completed.

1.2.4.2 Structural Integrity

The scope and schedule of in-service inspections at Darlington were based on the most recent revision of OPG's component aging and life-cycle management strategy and plans. While the programs were generally up-to-date, corrective actions were still required for certain components. Overall, however, CNSC staff is satisfied with both the basis for these plans and the adequacy of documentation.

Feeders are currently thinning at a higher rate than expected by OPG. OPG continues to regularly update CNSC staff on its management of *feeder* performance and degradation. During the spring of 2005, 245 *feeders* were inspected for pipe wall thinning at Unit 2, and 230 *feeders* were inspected for cracking. The licensee also checked for cracks in repaired "Grayloc" *feeder* connection welds. Except for one *feeder*, all pipes in Unit 2 were assessed to be fit for service. The one *feeder* pipe was found to have a wall thickness near the Grayloc weld that was below the minimum required value. The licensee provided a supporting stress analysis to demonstrate that the *feeder* is fit for service until March 2008.

All four *steam generators* (SG) at Unit 2 were inspected during the spring 2005 outage. CNSC staff judges that the inspection results were adequate and that OPG showed that the Unit 2 SGs can operate safely until the next planned outage.

In 2005, CNSC staff reviewed OPG's report on the metallurgical examination of SG tubes removed from Unit 1 during the spring 2004 outage. The examination showed there was no evidence of fatigue cracking, stress corrosion cracking, or intergranular attack associated with any of the flaws in the examined areas. This examination, along with the final inspection results, supported the conclusion that the Unit 1 SGs are fit for service.

1.2.4.3 Reliability

CNSC staff is satisfied with OPG's progress in continuing to develop the Darlington reliability program to meet the requirements of regulatory standard S-98 ("Reliability Programs for Nuclear Power Plants"), which was issued in 2005.

Systems important to safety performed well in terms of their availability in 2005. However, due to a human error, SDS #2 was declared unavailable for a short period of time and corrective actions were subsequently taken to prevent a recurrence.

1.2.4.4 Equipment Qualification

There was a relatively large number of events associated with steam-protected rooms in 2005 (e.g., doors left open). This is an indication that the level of awareness of the EQ program among Darlington staff was unsatisfactory and that additional training may be required to ensure long-term sustainability of the program. Of particular concern was the discovery that the envelope of conditions in the EQ room conditions manual was not supported by the Darlington safety report. There appeared to be a lack of integration of EQ requirements and supporting documentation with the safety requirements identified in operational safety requirements documentation. This finding is a recent one and CNSC staff will be closely monitoring its follow-up and resolution.

1.2.5 Emergency Preparedness

Site	SAFETY AREA	Grades	
		Program	Implementation
Darlington	EMERGENCY PREPAREDNESS	A	A

A comprehensive evaluation of the licensee’s response to a major simulated radiological event was undertaken at Darlington in 2005. CNSC staff concluded that, within the scope of this emergency exercise, OPG demonstrated its preparedness and competence in dealing with a simulated accident, its exchange of information at the federal, provincial and local levels, and its aptitude in decision making. Darlington's ability to implement the emergency preparedness response program during a simulated emergency exceeded expectations.

1.2.6 Environmental Protection

Site	SAFETY AREA	Grades	
		Program	Implementation
Darlington	ENVIRONMENTAL PROTECTION	B	B

The Environmental Protection program and its implementation at Darlington met CNSC expectations in 2005. Both airborne emissions and liquid releases of nuclear substances to the environment were below the *derived release limits* for Darlington. Consequently, the estimated radiation doses to the public were well below the regulatory limits. Also, there were no unplanned releases of nuclear substances or hazardous substances from Darlington in 2005 that posed an unreasonable risk to the environment.

1.2.7 Radiation Protection

Site	SAFETY AREA	Grades	
		Program	Implementation
Darlington	RADIATION PROTECTION	B	B

CNSC staff assessed the Radiation Protection program at the Darlington site by focusing on *type II inspection* follow-ups and by addressing daily ongoing issues. In 2005, Darlington continued to meet the implementation requirements for all elements of its Radiation Protection programs. Any identified deficiencies were considered to be minor and did not pose a threat to the health and safety of workers.

1.2.8 Site Security

The assessment of the Site Security safety area for Darlington is documented in a separate (secret) *Commission Member Document* (CMD 06-M35.A).

1.2.9 Safeguards

Site	SAFETY AREA	Grades	
		Program	Implementation
Darlington	SAFEGUARDS	B	B

In 2005, programs at Darlington to help fulfill Canada's obligations with respect to international *safeguards* met the applicable legal requirements and CNSC staff expectations.

In 2005, there was a reportable event at Darlington due to the breakage of a paper seal during a physical inventory inspection carried out by the *International Atomic Energy Agency* (IAEA). Corrective measures were taken and the inspection was completed successfully. Follow-up steps were put in place to prevent recurrence of this type of event.

1.3 PICKERING-A

1.3.1 Operating Performance

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Pickering A	OPERATING PERFORMANCE	B	B
	Organization & Plant Management	B	B
	Operations	B	B
	Occupational Health & Safety (Non-radiological)	B	B

The operating licence for Pickering A was renewed in 2005 for a five-year period.

Both the program and implementation of the Operating Performance safety area at Pickering A met the expectations of Canadian Nuclear Safety *Commission* (CNSC) staff. The programs under the safety area contributed adequately to safe facility operation in 2005 and, in general, to the achievement of the CNSC's desired outcomes. Pickering A operated safely in 2005.

1.3.1.1 Organization and Plant Management

Ontario Power Generation (OPG) reacted conservatively to shut down Unit 4 when a potential problem with the *feeders* was identified in Unit 1 (see Section 1.4 for details).

During 2005, OPG completed the return-to-service project of Pickering A, Unit 1. CNSC staff determined that the appropriate commissioning tests and verifications were successfully completed by OPG and Unit 1 began full power operation in October. The post-restart operation and safety performance of Unit 1 were good. In 2005, OPG also informed CNSC staff of its decision not to return Pickering Units 2 and 3 to service (see Section D.4.6). Instead, Units 2 and 3 will be placed in long-term safe storage. OPG's intent is to remove the fuel and heavy water from the reactors.

During 2005, there were three operational transients at Pickering A—two trips and one *setback* (see Table 1). One of the trips occurred when the reactor was sub-critical. The other was a reactor trip on Unit 4 caused by a heat transport system (HTS) pump trip, followed by a *setback* from 94% to 92.8% power. There were no anomalies noted in Unit 4's response to the trip and CNSC staff considers that licensee staff responded correctly to safely shut down the reactor. Since this event, OPG developed an inspection and replacement strategy for the HTS pump coolers to prevent recurrence.

OPG provided CNSC staff with the latest revision of the OPG Nuclear Charter and Nuclear Organization documents. CNSC staff agreed that they still retain the attributes of an overall quality assurance program, as defined by Canadian Standards Association (CSA) N286.0.

The annual decommissioning financial guarantee status report for 2005 was submitted to the CNSC by OPG and it addressed a number of recent developments, including the decision by OPG to permanently shut down Units 2 and 3 at Pickering A. CNSC staff reviewed the information and agreed that the financial guarantee remains valid, in effect, and sufficient to meet the decommissioning needs of Pickering A.

1.3.1.2 Operations

CNSC staff conducted a series of field compliance inspections at Pickering A during 2005 (e.g., reactor buildings, turbine building, and the main control room). CNSC staff found good performance in the conduct of operations and few deficiencies were identified.

CNSC staff conducted an assessment of the forced outage of Unit 4 in 2005. The results of the assessment were that the outage activities were planned and completed adequately and met CNSC requirements. The assessment also made two recommendations to improve the procedures for forced outages and the timeliness of readiness-for-service summary reports.

In September 2005, an *International Atomic Energy Agency* (IAEA) Operational Safety Review Team (OSART) had a follow-up visit to Pickering A to assess OPG's progress in addressing the recommendations and suggestions made by the February 2004 OSART mission. The team concluded that Pickering A made significant progress in correcting all issues identified during the 2004 mission. See Section D.4.10 for details.

Based on the review of event reports, CNSC staff considers that OPG met the CNSC's event reporting requirements for Pickering A, including prompt detection and analysis of events and provision of adequate information.

1.3.1.3 Occupational Health and Safety (Non-radiological)

CNSC staff considers that the accident frequency and severity rates, reported by OPG during 2005, demonstrated good occupational health and safety performance at Pickering A. The value of the "Accident Severity Rate" performance indicator at Pickering A and B (2.0 in 2005) was only slightly above the value for the whole industry (see Tables 9 and 10). Overall, the Occupational Health and Safety program and implementation met CNSC performance expectations.

1.3.2 Performance Assurance

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Pickering A	PERFORMANCE ASSURANCE	B	B
	Quality Management	B	B
	Human Factors	B	B
	Training, Examination, and Certification	B	B

Both the program and implementation of the Performance Assurance safety area at Pickering A met CNSC staff's expectations. The programs under the safety area contributed adequately to safe facility operation in 2005 and, in general, to the achievement of CNSC's desired outcomes.

1.3.2.1 Quality Management

In 2005, CNSC *type I inspections* identified discrepancies with respect to OPG's management oversight and leadership, specifically in the areas of self-assessment and independent assessments. OPG updated and implemented the governing procedure.

Corrective actions regarding procedure adherence and usability were ongoing throughout 2005. At the end of the year, OPG submitted data to the CNSC to demonstrate the effectiveness of the corrective actions taken. However, a review of event reports in 2005 identified a number of events that resulted from non-adherence to procedures and insufficient direction. The effectiveness of the corrective actions proposed by OPG continues to be reviewed by CNSC staff.

1.3.2.2 Human Factors

Based on compliance activities carried out in 2005, Pickering A met the CNSC's expectations for its Human Factors program and its implementation.

CNSC staff is currently reviewing information requested from Pickering A to support the adequacy of minimum shift complement staffing during events that could affect multiple units.

The 2005 Pickering A human performance plan identified eight focus areas for the station, including self assessments, use of operating experience, and support for contractors and new hires. OPG assigned management accountability for the specific human performance initiatives and targets.

1.3.2.3 Training, Examination, and Certification

One certified staff training program was evaluated at Pickering A in 2005: the initial simulator training program for Shift Managers/Control Room Shift Supervisors. In addition, an evaluation was conducted on the diagnostic simulator-based testing component of the requalification testing process at Pickering A.

CNSC staff continued the ongoing review of Pickering A's incorporation of the station-specific program objectives into the initial training program for Authorized Nuclear Operators. This initiative is resource-intensive and is currently on schedule to meet its target completion date in 2006.

Although evaluations conducted during 2005 identified some deficiencies, progress was made by Pickering A to fulfill its corrective action commitments in the certified and non-certified staff training programs and the requalification testing program. In addition, the success rate in certification examinations at Pickering A was adequate.

1.3.3 Design and Analysis

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Pickering A	DESIGN AND ANALYSIS	B	B
	Safety Analysis	B	B
	Safety Issues	B	B
	Design	B	B

Both the program and implementation of the Design and Analysis safety area at Pickering A met CNSC staff's expectations. The programs under the safety area contributed adequately to safe facility operation in 2005 and, in general, to the achievement of CNSC's desired outcomes. CNSC staff reviews concluded that the licensee continued to provide acceptable safety analyses and responses to new design and safety issues.

1.3.3.1 Safety Analysis

CNSC staff reviews confirmed that Pickering A performed acceptable safety analysis in 2005 and made adequate progress toward updating its safety report. OPG's funding of research programs and its monitoring and assessment of new information and research findings to ensure the validity of the safety analysis were considered satisfactory.

1.3.3.2 Safety Issues

CNSC staff reviewed the progress made by the various industry teams to resolve the generic action items (GAI). OPG continued to participate on the teams and the overall progress toward resolution of the GAIs was satisfactory. For more details on particular safety issues, see Appendix E for developments in each GAI in 2005.

1.3.3.3 Design

In 2005, a deficiency was discovered in the stack particulate monitoring system. There was a loss of signal from the system that went undetected because of a design deficiency that allowed a system failure mode to exist without a corresponding stack monitor alarm. An additional alarm was added to the software to provide a warning for this type of event.

Unavailability of the standby Class III power system was attributed to a deficiency in the design process for a digital controller, resulting in incorrect temperature set-point information in its documentation. The licensee identified and planned actions to correct the situation, including correcting the information and reviewing Class III system documentation.

1.3.4 Equipment Fitness For Service

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Pickering A	EQUIPMENT FITNESS FOR SERVICE	B	B
	Maintenance	B	B
	Structural Integrity	B	B
	Reliability	B	B
	Equipment Qualification	B	B

Both the program and implementation of the Equipment Fitness for Service safety area at Pickering A met CNSC staff's expectations. The programs under the safety area contributed adequately to safe facility operation in 2005 and, in general, to the achievement of the CNSC's desired outcomes.

1.3.4.1 Maintenance

OPG has processes and procedures in place that provide direction and support for its maintenance program. They contributed positively to the overall maintenance program at Pickering A in 2005.

Pickering has processes and procedures in place for work planning and backlog reduction, surveillance and inspection of structures, systems, and components, and plant life management. Implementation of the plant life management program was not yet completed.

1.3.4.2 Structural Integrity

The results of periodic inspections at Pickering A Unit 1 identified some deficiencies regarding supports for HTS components that required corrective actions and dispositioning. CNSC staff requested that OPG investigate the causes and impacts of these deficiencies; a resolution is ongoing.

OPG obtained "scrape" samples from fifteen *pressure tubes* in Unit 1 between October 2004, and January 2005. This was the first time that scrape sampling was performed in Pickering A after the large-scale fuel channel replacement in 1987. The results confirmed that Pickering A Unit 1 fuel channels were fit for their return to service. No other fuel channel inspection or maintenance activities were planned or performed for Pickering A units in 2005.

OPG shut down Pickering Unit 4 in April 2005 following the discovery of unexpected wall thinning in four *feeder* pipes that were removed from Pickering Unit 1 in late 2004. To ensure the continued safe operation of the units, OPG conducted additional inspections and analyses to assess the extent of wall thinning and replaced three more *feeders*. CNSC staff judged that the results of the *feeder* inspections at Pickering A were acceptable and supported the continued safe operation of Units 1 and 4, which were subsequently restarted in 2005. See Section D.4.4 for more details.

OPG inspected ten *steam generators* (SG) from 2001 to 2005 in preparation for the restart of Unit 1. During the unplanned spring 2005 outage, OPG partially inspected all twelve Unit 4 SGs. The metallurgical examination of a tube from a Unit 4 SG confirmed the presence of an axial crack initiating from the outside surface of the tube. Based on the review, CNSC staff raised some concerns about the structural integrity of SG tubing at Unit 1, which OPG addressed.

Discovery of "indications" on the inner surface of the tube (likely associated with intergranular attack), along with outside diameter cracking, raised the need for revision of the Pickering SG life-cycle management plan. OPG provided its plans for the SG program and the Pickering SG life-cycle management program. CNSC staff concluded that the submission supported a return to service of Unit 1 SGs, as well as continued safe operation of the Unit 4 SGs.

1.3.4.3 Reliability

In 2005, OPG continued to implement the requirements in the new regulatory standard S-98 ("Reliability Programs for Nuclear Power Plants"). The plans for compliance with S-98 have been developed consistently with the industry approach.

In 2005, CNSC staff conducted an inspection on one aspect of the Pickering A reliability program—records and data handling processes. The inspection indicated that the process to collect and treat reliability data, data handling training, and the computer software fall below the CNSC's expectation to have formal processes in place. The deficiency in the process appears to be compensated by the diligence of OPG staff. OPG has submitted a plan and schedule to complete the necessary corrective actions.

All the *special safety systems* at Pickering A met the regulatory reliability targets in 2005, although the emergency core cooling (see Sections D.4.1, D.4.7, and D.4.8) and containment systems experienced impairments. Other systems important to safety met their reliability targets except for the Class III power system for Units 1 and 2 while in the *lay-up state*.

1.3.4.4 Equipment Qualification

There was no new information on the *environmental qualification* (EQ) program submitted for Pickering A in 2005. The action plan and measures that OPG put in place to address the inspection findings from 2004 should advance the implementation of the EQ program at Pickering A and make it sustainable.

1.3.5 Emergency Preparedness

Site	SAFETY AREA	Grades	
		Program	Implementation
Pickering A	EMERGENCY PREPAREDNESS	A	A

Ongoing compliance activities at Pickering A did not identify any evidence suggesting that emergency preparedness degraded in any way to justify a change in their assessment from last year. The emergency response aspect of the overall response to the suspicious items found at Unit 1 (see Section D.4.5) was appropriate. The Emergency Preparedness program and its implementation at Pickering A continued to exceed expectations.

1.3.6 Environmental Protection

Site	SAFETY AREA	Grades	
		Program	Implementation
Pickering A	ENVIRONMENTAL PROTECTION	B	B

The Environmental Protection program and its implementation at Pickering A met CNSC staff's expectations in 2005. Available monitoring data from 2005 for both airborne emissions and liquid releases of nuclear substances for Pickering A showed that releases to the environment were consistently below the *derived release limits*. Based on the environmental radiological data for 2004, estimated radiation doses to the public were well below the regulatory limit. There were no unplanned releases of nuclear substances or hazardous substances from Pickering A that posed an unreasonable risk to the environment.

1.3.7 Radiation Protection

Site	SAFETY AREA	Grades	
		Program	Implementation
Pickering A	RADIATION PROTECTION	B	B

Doses at Pickering A for 2005 were over OPG's targets as a result of *feeder* inspections and repairs. Numerous on-power boiler room entries were conducted at Units 1 and 4 to check for leakage and to address equipment alarms and problems. However, the doses were not over the regulatory limits and were not considered to pose unreasonable risks to the workers involved.

The progress of the action plan to address the May 2004 *type II inspection* at Pickering A is satisfactory; completion is scheduled for 2006.

In 2005, Pickering A continued to meet the implementation requirements for all elements of its Radiation Protection programs. Any identified deficiencies were considered to be minor and did not pose a threat to the health and safety of workers.

1.3.8 Site Security

The assessment of the Site Security safety area for Pickering A and B is documented in a separate (secret) *Commission Member Document* (CMD 06-35.A).

1.3.9 Safeguards

Site	SAFETY AREA	Grades	
		Program	Implementation
Pickering A	SAFEGUARDS	B	B

In 2005, programs at Pickering A to help fulfill Canada's obligations with respect to international *safeguards* met the applicable legal requirements and CNSC staff's expectations.

In 2005, entry to the site by an IAEA inspector was delayed because of identification concerns. A corrective action plan highlighting training for security staff and updating Pickering's access control procedures as a means of addressing prompt IAEA access was completed.

1.4 PICKERING-B

1.4.1 Operating Performance

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Pickering B	OPERATING PERFORMANCE	B	B
	Organization & Plant Management	B	B
	Operations	B	B
	Occupational Health & Safety (Non-radiological)	B	B

Pickering B is approximately in the middle of the five-year period covered by its operating licence.

Both the program and implementation of the Operating Performance safety area at Pickering B met the expectations of Canadian Nuclear Safety *Commission* (CNSC) staff. The programs under the safety area contributed adequately to safe facility operation in 2005 and, in general, to the achievement of the CNSC's desired outcomes. Pickering B operated safely in 2005.

1.4.1.1 Organization and Plant Management

During 2005 there were two reactor trips at Pickering B—both on Unit 8. The first was due to shutdown system (SDS) maintenance (included in Table 1) and the second resulted from a turbine trip during the restart following the first reactor trip. There were also several forced outages due to turbine generator problems and a multi-unit outage due to algae in the cooling water intake (see Section D.5.4). No significant problems were noted by CNSC staff during any of these transients and Ontario Power Generation (OPG) has taken corrective actions to address the equipment problems which caused, or contributed to, the events.

There were nine unplanned transients at Pickering B in 2005, but only two were trips (see Table 1). This compared favourably with the 14 unplanned transients in 2003 (see Table 3), which included eight trips. The "Unplanned Capability Loss Factor" performance indicator (PI) also decreased substantially since 2003 (see Table 5). Based on the continued, general improvement since 2003 in operations and the reductions in the number of trips, other transients, and forced outages, implementation of Organization and Plant Management is now considered to meet CNSC expectations.

OPG provided CNSC staff with the latest revision of the OPG Nuclear Charter and Nuclear Organization documents. CNSC staff agreed that they still retain the attributes of an overall quality assurance program, as defined by Canadian Standards Association (CSA) N286.0.

The annual decommissioning financial guarantee status report for 2005 was submitted to the CNSC by OPG. CNSC staff reviewed the information and agreed that the financial guarantee remains valid, in effect, and sufficient to meet the decommissioning needs of Pickering B.

1.4.1.2 Operations

CNSC staff conducted a series of field compliance inspections at Pickering B during 2005 (e.g., reactor buildings, turbine building, and the main control room). CNSC staff found good performance in the conduct of operations and few deficiencies were identified. CNSC staff assessed planned outages and found that, although issues such as resources, parts availability, discovery work and re-work continued to affect outage performance, the outages were planned and completed adequately. CNSC staff also recommended that OPG improve the quality of post-outage, "lessons-learned" review meetings and the readiness-for-service summary reports.

Based on the review of event reports, CNSC staff considers that OPG met the CNSC's event reporting requirements for Pickering B, including prompt detection and analysis of events and provision of adequate information.

1.4.1.3 Occupational Health and Safety (Non-radiological)

CNSC staff considers that the accident frequency and severity rates, reported by OPG during 2005, demonstrated good occupational health and safety performance at Pickering B. The value of the "Accident Severity Rate" PI at Pickering A and B (2.0 in 2005) was only slightly above the value for the whole industry (see Tables 9 and 10). Overall, the Occupational Health and Safety program and implementation met CNSC performance expectations.

1.4.2 Performance Assurance

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Pickering B	PERFORMANCE ASSURANCE	B	B
	Quality Management	B	B
	Human Factors	B	B
	Training, Examination, and Certification	B	B

Both the program and implementation of the Performance Assurance safety area at Pickering B met CNSC staff's expectations. The programs under the safety area contributed adequately to safe facility operation in 2005 and, in general, to the achievement of the CNSC's desired outcomes. During the compliance inspections, CNSC staff observed that the policies and procedures, work environment, and individual attitudes and behaviours in place within OPG demonstrated good safety culture at Pickering B. CNSC staff also recognized that OPG evaluates its safety culture to identify both positive attributes and areas for continuous improvement.

1.4.2.1 Quality Management

CNSC *type I inspections* identified discrepancies with OPG management oversight and leadership, specifically in the areas of self-assessment and independent assessments. OPG updated and implemented the governing procedure.

Corrective actions regarding procedure adherence and usability were ongoing throughout 2005. At the end of the year, OPG submitted data to the CNSC to demonstrate the effectiveness of the corrective actions taken. However, a review of event reports in 2005 identified a number of events that resulted from non-adherence to procedures and insufficient direction. The effectiveness of the corrective actions proposed by OPG continues to be reviewed by CNSC staff.

At the time of the licence renewal for Pickering B in 2003, problems were identified with the trending of data in OPG's problem identification, resolution, and corrective action plans (see 2004 industry report CMD 05-M31). Since then, OPG assessed the causes and corrected the specific deficiencies to prevent similar problems. OPG also self-assessed the implementation of the corrective actions. CNSC staff will revisit this issue to confirm that the corrective actions have been effective.

1.4.2.2 Human Factors

Based on compliance activities in 2005, Pickering B met CNSC's expectations for its Human Factors program and its implementation. Section 2.2.2 describes licence amendments in 2005 at Pickering B to formalize timeframes for improvements in certified staffing. CNSC staff is currently reviewing information from Pickering B to support the adequacy of minimum shift complement staffing during events that could affect multiple units.

The 2005 Pickering B human performance plan identified eight focus areas for the station, including self assessments, use of operating experience, and support for contractors and new hires. OPG assigned management accountability for the specific human performance initiatives and targets.

In 2005, CNSC staff observed a successful validation exercise of the minimum shift complement during a simulated loss of coolant accident.

1.4.2.3 Training, Examination, and Certification

One non-certified staff training program was evaluated in 2005 (Radiation Protection training program) as part of a CNSC integrated *type I inspection* of the Radiation Protection program at Pickering B.

CNSC staff continued the ongoing review of Pickering B's incorporation of the station-specific program objectives into the initial training program for Authorized Nuclear Operators. This initiative is resource-intensive and is currently on schedule to meet its target completion date in 2006.

On November 16, 2005, the Unit 8 liquid zone compressor discharge non-return valve failed open resulting in the rapid cycling of the compressor and a power transient. According to the Operations Manager, the control room crew response to this liquid zone system event did not meet the expected standard in the area of conservative decision making. CNSC staff is reviewing this event and following up with Pickering B.

Although evaluations conducted during 2005 identified some deficiencies, progress was made by Pickering B to fulfill its corrective action commitments in the training programs for certified and non-certified staff and the requalification testing program. In addition, the success rate in certification examinations at Pickering B was adequate.

1.4.3 Design and Analysis

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Pickering B	DESIGN AND ANALYSIS	B	C
	Safety Analysis	B	B
	Safety Issues	B	B
	Design	B	C

At Pickering B, the implementation of the Design and Analysis safety area was below expectations. Design changes to correct the deficiencies that were highlighted during the August 2003 blackout were not yet complete.

1.4.3.1 Safety Analysis

CNSC staff reviews confirmed that Pickering B performed acceptable safety analysis in 2005 and made adequate progress toward updating its safety report. OPG's funding of research programs and its monitoring and assessment of new information and research findings to ensure the validity of the safety analysis were considered satisfactory.

At the time of the licence renewal for Pickering B in 2003, two safety analysis issues were identified that warranted continued monitoring. The first was with respect to changes to plant configuration due to aging (e.g., *pressure tube* creep), which can impact the assumptions used in accident analysis. OPG's efforts to monitor changes due to aging effects, and assess their potential impact on accident analysis in the short term (within the license period), are considered adequate. OPG is currently working on a long-term approach and CNSC staff continues to monitor this work closely.

The second issue was with respect to the capacity of the plant to dissipate fuel decay heat in an accident scenario involving a sustained loss of all engineered heat sinks. CNSC staff reviewed OPG's assessment of this issue and concluded that the risk to the public from this event was very small and that no further action was required.

1.4.3.2 Safety Issues

CNSC staff reviewed the progress made by the various industry teams to resolve the generic action items (GAI). OPG continued to participate on the teams and the overall progress toward resolution of the GAIs was satisfactory. For more details on particular safety issues, see Appendix E for developments in each GAI in 2005.

1.4.3.3 Design

Deficiencies in the design of some of the systems at Pickering B were made evident during the August 2003 blackout. The deficiencies impacted the overall defence-in-depth of the station. Ongoing issues with respect to service water and fire water are described in Section D.5.1. The main deficiency, though, was the inability to cool down the reactor after a loss of the electricity grid, requiring the units to remain hot and dependent on thermo-syphoning to remove the decay heat.

OPG has installed an interim power supply to provide sufficient power for cooling of one unit should a loss of off-site power occur and the need arises for cooling of a single unit. Permanent large combustion turbine units are being installed to provide sufficient power to all units. In addition, modifications have been completed to improve the likelihood of the units continuing to operate after a similar event. Implementation of the Design program at Pickering B will continue to be rated below requirements until the combustion turbines have been installed and the units are able to be cooled if off-site power is lost.

In 2005, CNSC staff reviewed selected elements of fire protection implementation. The licensee's fire protection improvement program has been largely completed, although some questions remain related to the adequacy of fire water capacity for certain design basis events.

Pickering B experienced some minor situations in 2005 revealing legacy design issues that are being reviewed.

OPG issued operational safety requirements in 2005 that describe the "safe operating envelope" for 16 of the most important systems. The completion of these documents was the last step in the Configuration Management Closure Project—an important achievement towards better and safer operation at Pickering B.

In 2003, there was a de-mineralized water leak that shut down all four Pickering B units (see the 2003 industry report, CMD 04-M30). OPG repaired the leak in the de-mineralized water supply system and corrected its operating procedures. OPG has made some improvements to reduce the vulnerability of this system and further enhancements are being considered.

1.4.4 Equipment Fitness For Service

Site	SAFETY AREA Program	Grades Program	 Implementation
Pickering B	EQUIPMENT FITNESS FOR SERVICE	B	C
	Maintenance	B	C
	Structural Integrity	B	B
	Reliability	B	C
	Equipment Qualification	B	B

At Pickering B, the implementation of the Equipment Fitness for Service safety area is below expectations. Implementation problems have negatively affected the overall defence-in-depth of the station and have contributed to an increase in the frequency of incidents, accidents, and precursors. Also, there is a concern that the programs are not being implemented in a manner that achieves the necessary levels of compliance with the regulatory framework. In particular, the process of maintaining reliability of standby generators and other systems important to safety failed at many different levels including management, procurement, maintenance, and risk evaluation. It is also necessary for the licensee to set targets for maintenance backlogs and to demonstrate that it can meet those targets.

OPG has initiated an improvement program for equipment called “85/5”, which means a target capacity factor of 85% and a 5% forced-loss rate. While these values are aimed at production, the improvements to meet these targets also impact the safety performance of the plant. CNSC staff recognizes the need for such an improvement program and is monitoring the progress toward the targets.

1.4.4.1 Maintenance

OPG has processes and procedures in place that provide direction and support for its maintenance program. They contributed positively to the overall maintenance program for Pickering B in 2005.

Pickering has processes and procedures in place for work planning and backlog reduction, surveillance and inspection of structures, systems, and components, and plant life management. Implementation of the plant life management program is not yet completed.

Since the licence renewal in 2003, OPG completed the condition assessments that are part of its aging program for Pickering B.

CNSC staff reviewed the status of Pickering B’s maintenance performance in 2005 and found that the maintenance backlogs remain too large. There were signs of improvement in the areas of maintenance procedure upgrades, review of preventative maintenance report feedback, and change requests and the instrument calibration program. The areas of operating, shutdown, and preventative maintenance backlogs did not improve significantly. Implementation of the Maintenance program will continue to be considered below requirements until OPG demonstrates that Pickering B’s backlogs meet targets to which CNSC staff has agreed.

1.4.4.2 Structural Integrity

During the planned and forced outages in 2005, OPG examined and performed maintenance activities on fuel channels in Units 5 and 6. Ten fuel channels in Unit 5 and fifteen fuel channels in Unit 6 were inspected over their full length. New operational restrictions, based on the dispositions of the most restrictive flaws, were accepted by CNSC staff. Although no fuel channel inspections or maintenance were conducted for Units 7 and 8 in 2005, OPG re-assessed their susceptibility to fuel channel contact and hydride blister formation and the results supported their continuous operation until the next planned outages in 2006, when spacer location and repositioning is planned.

During the spring 2005 outage of Pickering B Units 5 and 6, OPG inspected *feeders* for wall thinning and cracking. OPG submitted an analysis that defined the required wall thicknesses for Pickering B *feeders* and CNSC staff found it to be acceptable. CNSC staff is currently reviewing OPG's updated *feeder* piping aging management strategy and plan.

Unit 5 was shut down after its restart due to broken locking tabs in three *steam generators* (SG). OPG notified CNSC staff that the divider plate seal skins and associated components were replaced and that small portions of seal skin might reside in the heat transport system. OPG provided an assessment demonstrating that the skin fragments had no impact on safety. CNSC staff concluded that OPG's proposed action plan was appropriate.

OPG inspected six SGs at each of Units 5 and 6. CNSC staff accepted OPG's conclusion that the SGs of Units 5 and 6 can safely continue to operate until the next scheduled outage.

1.4.4.3 Reliability

In 2005, OPG continued to implement the requirements in the new regulatory standard S-98 ("Reliability Programs for Nuclear Power Plants"). The plans for compliance have been developed consistently with the industry approach.

In 2005, CNSC staff conducted an inspection on one aspect of the Pickering B reliability program—records and data handling processes. The inspection indicated that the process to collect and treat reliability data, data handling training, and the computer software fell below CNSC's expectation to have formal processes in place. The deficiency in the process appeared to be compensated by the diligence of OPG staff. OPG submitted a plan and schedule to complete the necessary corrective actions.

Containment and SDS #1 experienced periods of impairment in 2005, but these two systems still met the annual reliability targets. However, an impairment of the emergency core coolant system resulted in the system reliability not meeting its regulatory target. The impairments of these *special safety systems* were attributed to operator errors, deficiencies with the maintenance program and operating procedures, and weaknesses in the process to identify and implement corrective action to prevent recurrence.

The other systems important to safety met their reliability targets in 2005 except for the Class III power and off-site electrical systems. There were four incidents in which these electrical systems were declared unavailable due to different causes (more details are provided in Sections D.5.2 and D.5.3). The *root-cause analysis* identified significant deficiencies in the overall management of reliability of these systems. There were long-lasting unresolved issues that made the performance and reliability of the Class III electrical system fall below CNSC staff expectations. OPG management failed to recognize the risk-significance of the issues, thereby delaying the improvement projects. Insufficient attention was paid to degraded material conditions, availability of spares, and the corrective action program.

In 2006, OPG completed the Pickering B probabilistic risk assessment (PRA).

1.4.4.4 Equipment Qualification

A CNSC inspection of the Pickering B *environmental qualification* (EQ) program determined that the program and its implementation met the intent of the CNSC acceptance criteria. The inspection found a satisfactory level of EQ awareness among station management and staff. OPG's new sustaining plan for EQ was found to be acceptable. However, there was a significant delay in the implementation of the condition and environmental monitoring subprogram.

1.4.5 Emergency Preparedness

Site	SAFETY AREA	Grades	
		Program	Implementation
Pickering B	EMERGENCY PREPAREDNESS	A	A

Ongoing compliance activities at Pickering B did not identify any evidence suggesting that emergency preparedness degraded in any way to justify a change in their assessment from last year. The Emergency Preparedness program and its implementation at Pickering B continued to exceed expectations.

1.4.6 Environmental Protection

Site	SAFETY AREA	Grades	
		Program	Implementation
Pickering B	ENVIRONMENTAL PROTECTION	B	B

The Environmental Protection program and its implementation at Pickering B met CNSC expectations in 2005. Both airborne emissions and liquid releases of nuclear substances to the environment were below the *derived release limits* (DRL) for Pickering B. Based on the environmental radiological data for 2004, estimated radiation doses to the public were well below the regulatory limit. There were no unplanned releases of nuclear substances or hazardous substances from Pickering B that posed an unreasonable risk to the environment. The spill of heavy water in December 2005 resulted in an emission to the environment that was well below regulatory limits (see Section D.5.5).

At the time of the licence renewal for Pickering B in 2003, an issue was identified that related to the accurate measurement of noble gas emissions at levels well below the DRL. Since then, OPG has focussed on resolving problems with new, more sensitive stack monitoring equipment installed at Pickering A Units 1 and 4. OPG intends to install the same system at Pickering B if the problems are resolved; otherwise, it will consider other suppliers. There is also a network of gamma spectrometers in the area that provide a more direct estimate of external dose to the public from noble gas emissions. Historically, the doses due to these emissions from the station have been insignificant relative to background readings.

In a separate development, a tritium off-gassing facility was installed in November 2004, and has been operating since that time.

At the time of the licence renewal for Pickering B in 2003, an issue was identified which related to the use of conservative, interim DRLs while the human health pathways models, on which the DRLs are based, were being updated. Since then, OPG updated the human health pathways and the actual DRLs for Pickering. CNSC staff accepted the Pickering DRL revisions, although the interim DRLs are still in place pending a licence amendment.

1.4.7 Radiation Protection

Site	SAFETY AREA	Grades	
		Program	Implementation
Pickering B	RADIATION PROTECTION	B	B

Pickering B experienced two “action level” events in 2005—tritium uptakes exceeded the action levels and OPG reported the events to the CNSC. Dose performances at Pickering B for 2005 were over target, but they were below the regulatory limits and were not considered to pose unreasonable risks to the workers involved.

In April and May of 2005, CNSC conducted a *type I inspectio*n of the Pickering B Radiation Protection program and issued twelve actions notices. CNSC staff is reviewing OPG’s corrective action plan and is planning follow up compliance activities.

In 2005, Pickering B continued to meet the implementation requirements for all elements of its Radiation Protection programs. Any identified deficiencies were considered to be minor and did not pose a threat to the health and safety of workers.

1.4.8 Site Security

The assessment of the Site Security safety area for Pickering B is documented in a separate (secret) *Commission Member Document* (CMD 06-M35.A).

1.4.9 Safeguards

Site	SAFETY AREA	Grades	
		Program	Implementation
Pickering B	SAFEGUARDS	B	B

In 2005, programs at Pickering B to help fulfill Canada's obligations with respect to international *safeguards* met the applicable legal requirements and CNSC staff's expectations.

In 2005, there were two noteworthy events at Pickering B that impacted *safeguards*. In one event, power to a fuel bundle counter was interrupted for approximately four and a half days. Pickering B staff acted promptly to provide an alternate power supply. In the other event, while two spent fuel bundles were passing the detectors of the same bundle counter, the breaker of the temporary power supply tripped. The breaker was reset within 10 minutes and the fuel bundle counter was reconnected to the permanent power supply after the maintenance outage. In both these events, there was no loss of *safeguards* data.

Also in 2005, entry to the site by an *International Atomic Energy Agency* (IAEA) inspector was delayed because of identification concerns. A corrective action plan to facilitate prompt IAEA access, highlighting training for security staff and updating Pickering's access control procedures, was completed.

1.4.10 Conclusion for Pickering B

OPG operated Pickering B safely during 2005 and continued to take appropriate actions to improve plant material condition and to correct the design deficiencies identified as a result of the blackout in August 2003. In particular, there was ongoing progress towards installation of the combustion turbine generators.

Since the licence renewal in 2003, the number of transients and forced outages has improved at Pickering B. The Organization and Plant Management program is now considered to meet requirements. OPG has made progress on several programs designed to improve performance and safety, including:

- implementation of the "85/5" improvement program for equipment;
- the issue and implementation of operational safety requirements that describe the "safe operating envelope" for 16 of the most important systems;
- completion of the Pickering B PRA; and
- completion of the condition assessments for the aging program.

All the programs in the Performance Assurance safety area, as well as their implementation, are now considered to meet requirements. However, the implementation of the Reliability program is now considered to be below requirements for Pickering B due to the incidents of unavailability of safety systems in 2005.

1.5 GENTILLY-2

1.5.1 Operating Performance

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Gentilly-2	OPERATING PERFORMANCE	B	B
	Organization & Plant Management	B	B
	Operations	B	B
	Occupational Health & Safety (Non-radiological)	B	B

Both the program and implementation of the Operating Performance safety area at Gentilly-2 met Canadian Nuclear Safety *Commission* (CNSC) staff's expectations. The programs under the safety area contributed adequately to safe facility operation in 2005 and, in general, to the achievement of the CNSC's desired outcomes. Although Gentilly-2 operated safely in 2005, there was some degradation that Hydro-Québec should address promptly.

1.5.1.1 Organization and Plant Management

There were no *serious process failures* at Gentilly-2 in 2005. Automatic systems acted according to their design for the three transients that occurred: one reactor trip (preceded by a *stepback*), one *stepback* and one *setback* (see Table 1). The reactor *setback* in 2005, as well as a *stepback* in 2004, involved configuration management difficulties. CNSC staff views timely correction of these difficulties to be important to the maintenance of defence-in-depth.

Hydro-Québec's management processes were in compliance with applicable standards, and programs were in place to govern housekeeping and foreign material exclusion. Some difficulties were experienced with respect to the implementation of these programs in 2005. However, there was some improvement over the past performance and CNSC staff is following up with Hydro-Québec.

It was discovered early in 2005 that Hydro-Québec had not completed and documented some required self-assessments, which are key activities to ensure effective fulfillment of the licensee's safety responsibilities. This is also discussed in Section 1.5.2.1.

The public information program and decommissioning guarantee met CNSC requirements in 2005.

1.5.1.2 Operations

The programs covering procedural adherence, communications, change control, outage management and operator certifications were not formally evaluated in 2005, but are considered to remain satisfactory.

Procedural adherence was problematic in a variety of areas in 2005. Hydro-Québec made significant changes in the radiation protection area that, once fully implemented, should result in significant improvement.

Several incidents involving improper valve positioning were observed in 2005. Hydro-Québec's documentation control process was also found to be problematic, specifically with respect to updating information and controlling document revisions. CNSC staff is following up with Hydro-Québec with respect to both areas.

Operational practices assessed during the 2005 outage showed poor performance in a number of areas, including system alignment (configuration management), fire protection, foreign material exclusion, and personnel work protection. Incidents related to the cleaning of *steam generators* (SG) during the outage are described in Section D.6.2. Hydro-Québec undertook several initiatives aimed at improving outage performance. Before restart, CNSC staff conducted a special inspection that focused on system alignment and foreign material exclusion. This inspection revealed that Hydro-Québec had adequate measures in place to allow restart. Subsequent inspections by CNSC staff revealed no further problems.

1.5.1.3 Occupational Health and Safety (Non-radiological)

The value of the Accident Severity Rate performance indicator at Gentilly-2 (3.6 in 2005) was only slightly above the value for the whole industry (see Tables 9 and 10). The value for Gentilly-2 was slightly greater than in 2004 (1.2), but it remained considerably lower than the three previous years (see Table 11). Overall, the Occupational Health and Safety program and implementation met CNSC performance expectations.

1.5.2 Performance Assurance

Site	SAFETY AREA Program	Grades Program	 Implementation
Gentilly-2	PERFORMANCE ASSURANCE	B	C
	Quality Management	B	C
	Human Factors	B	C
	Training, Examination, and Certification	B	C

Weakness existed in the implementation of the Performance Assurance safety area that undermined the contribution of the safety area to overall defence-in-depth at Gentilly-2.

1.5.2.1 Quality Management

Follow-ups and inspections performed at Gentilly-2 in 2005 demonstrated that deficiencies existed in the implementation of the Quality Management program. Hydro-Québec did not provide proper evidence that the output of the management self-assessment process was effectively implemented. In addition, inspections demonstrated that Hydro-Québec experienced difficulties with procedural adherence, document control, record preservation, implementation of a supplier performance evaluation process, and providing effective output of the corrective action process.

1.5.2.2 Human Factors

Based on compliance activities carried out in 2005, Gentilly-2 met CNSC expectations for its human factors program and improvements were made in implementing elements of the human factors and human performance programs. However, implementation of the human performance program remained below expectations.

A number of initiatives have been taken by Hydro-Québec to improve human performance. However, there were delays in implementing recommendations following internal event analyses. Furthermore, concerns were raised regarding deficiencies in human performance, including a lack of conservative decision-making. The licensee has taken steps to address several of the issues and further regulatory activities will be carried out to confirm their effectiveness.

Gentilly-2 has developed a process for incorporating human factors into the engineering change process and applied it to a project involving the construction of a storage facility for solid radioactive waste. The licensee's submission met the expectations of CNSC staff.

In 2005, Gentilly-2 submitted a report on its self-evaluation of safety culture in 2004 that identified positive results (e.g., the use of operating experience, communications, etc.), as well as areas for improvement.

1.5.2.3 Training, Examination, and Certification

In 2005, no evaluations were conducted on certified staff training programs, non-certified staff training programs, or the re-qualification testing program at Gentilly-2. In addition, no certification examinations were conducted.

As requested by the CNSC, Gentilly-2 submitted an action plan to address the deficiencies identified by the 2003 and 2004 evaluations of the initial training program for certified staff. As of December 2005, this action plan was under review by CNSC staff. Although Gentilly-2 has not yet conducted a formal job and task analysis for Control Room Operators, this analysis is currently scheduled for completion in 2006. Hydro-Québec has requested the closure of several action notices from the past two CNSC evaluations.

In general, good progress was made by Gentilly-2 to fulfill its remaining corrective action commitments in the certified and non-certified staff training programs. However, the implementation of the Training, Examination and Certification program continued to be below requirements.

1.5.3 Design and Analysis

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Gentilly-2	DESIGN AND ANALYSIS	B	B
	Safety Analysis	B	B
	Safety Issues	B	B
	Design	B	B

Both the program and implementation of the Design and Analysis safety area at Gentilly-2 met CNSC staff's expectations. The programs under the safety area contributed to safe facility operation in 2005 and to the achievement of the CNSC's desired outcomes. CNSC staff's reviews concluded that the licensee continued to provide acceptable safety analyses and responses to new design and safety issues.

1.5.3.1 Safety Analysis

CNSC staff reviews confirmed that Gentilly-2 performed acceptable safety analysis in 2005 and is in the process of updating its safety report. Hydro-Québec's funding of research programs, as well as its monitoring and assessing of new information and research findings to ensure the validity of the safety analysis, were both considered satisfactory.

1.5.3.2 Safety Issues

CNSC staff reviewed the progress made by the various industry teams to resolve the generic action items (GAI). Hydro-Québec continued to participate on the teams and the overall progress toward resolution of the GAIs was satisfactory. For more details on particular safety issues, see Appendix E.

1.5.3.3 Design

In 2005, a Hydro-Québec internal audit found that its supplier performance evaluation process had several implementation deficiencies. For example, supplier's evaluation records and an approved suppliers list were not updated. Also, the implementation of the supplier performance evaluation follow-up procedure was not completed.

CNSC staff reviewed selected elements relating to the implementation of the facility's fire protection program in 2005. Reviews and assessments of event reports and the individual elements indicated no major weaknesses in the implementation of the program (with the exception of fire protection deficiencies noted during the 2005 outage).

Overall, the Design program and its implementation at Gentilly-2 met CNSC expectations.

1.5.4 Equipment Fitness for Service

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Gentilly-2	EQUIPMENT FITNESS FOR SERVICE	B	B
	Maintenance	B	B
	Structural Integrity	B	B
	Reliability	B	B
	Equipment Qualification	B	B

Both the program and implementation of the Equipment Fitness for Service safety area at Gentilly-2 met CNSC staff's expectations. The programs under the safety area contributed to safe facility operation in 2005 and to the achievement of the CNSC's desired outcomes.

1.5.4.1 Maintenance

Gentilly-2 has policies, processes and procedures in place that provide direction and support for its maintenance program. Hydro-Québec has brought in a new quality management system process model which includes core processes and sub-tier processes that are designed to meet the needs of its maintenance program. The program is supported by a significant organization with established goals.

1.5.4.2 Structural Integrity

CNSC staff's review of Gentilly-2's periodic inspection program revealed that more than 200 inspections scheduled for 2002, 2003, 2004 and 2005 were not performed.

In preparation for an April 2005 in-service inspection, a new suite of predictive computer models was used to prepare a list of fuel channels for spacer location and relocation (SLAR). The initial results for one channel indicated that the margin for time-to-contact, and subsequent hydride blister formation, was significantly less than the value accepted by CNSC staff. Hydro-Québec began a forced outage in December 2004 and performed SLAR on the channel and three other channels predicted to experience contact prior to the start of life-extension activities. Hydro-Québec informed CNSC staff that the four channels would be free of *pressure tube*-to-*calandria tube* contact until well after the planned start of life extension. See Section D.6.1 for more details.

An "indication" on a *feeder* connection weld was identified during *feeder* inspections in May 2005. Hydro-Québec characterized the indication as a lack of weld fusion and not a service-induced crack. Hydro-Québec submitted an assessment of fitness for continued service of the *feeder* that included a fatigue growth analysis and a crack stability analysis. Hydro-Québec concluded that the *feeder* was fit for service for a period of at least two years. CNSC staff approved the disposition of the indication and recommended re-inspection of the *feeder* weld during the next inspection to confirm its characteristics and monitor any unexpected changes in size.

1.5.4.3 Reliability

Hydro-Québec continued to implement the requirements in the new regulatory standard S-98 ("Reliability Programs for Nuclear Power Plants"). The plans for compliance were developed consistently with the overall industry approach.

The ability of systems that are important to safety to perform as intended met the regulatory requirements in 2005.

1.5.4.4 Equipment Qualification

In 2004, Hydro-Québec identified a number of corrective actions required to demonstrate that Gentilly-2 was compliant with its licence condition on *environmental qualification* and the associated acceptance criteria. Throughout 2005, Hydro-Quebec submitted a number of technical reports related to these actions. CNSC staff reviewed most of these submissions and found that Hydro-Québec has made good progress in resolving the outstanding issues. However, to ensure that the required corrective actions are complete, several documents will still be issued by Hydro-Québec and field modifications will be implemented.

1.5.5 Emergency Preparedness

Site	SAFETY AREA	Grades	
		Program	Implementation
Gentilly-2	EMERGENCY PREPAREDNESS	A	B

Hydro-Québec's response to an incident involving the inhalation of ammonia by two workers (see Section D.6.2) was considered adequate.

CNSC staff conducted a follow-up, *type II inspection* of an emergency exercise involving chlorine, which was staged at Gentilly-2 in 2005. The evaluation team concluded that, even though Gentilly-2 continued to demonstrate its capability to effectively manage its response to a radiological/nuclear emergency, it also revealed certain weak points in managing a chlorine-related emergency. Hydro-Québec has already taken appropriate measures to correct the deficiencies related to this aspect of its emergency response. There were no indications of major deviations from CNSC performance expectations.

During the site visit at Gentilly-2, the evaluation team also concluded that there was no evidence suggesting any degradation in the Emergency Preparedness program itself. All issues that the CNSC raised in previous inspections were addressed, or are currently being addressed, with no adverse effect on the capability, maintenance, or effectiveness of the emergency response. Hence, the program continues to exceed expectations.

1.5.6 Environmental Protection

Site	SAFETY AREA	Grades	
		Program	Implementation
Gentilly-2	ENVIRONMENTAL PROTECTION	B	B

The Environmental Protection program and its implementation at Gentilly-2 met CNSC expectations. Both airborne emissions and liquid releases of nuclear substances to the environment were below the *derived release limits* for Gentilly-2. Therefore, the estimated radiation doses to the public were well below the regulatory limits. There were no unplanned releases of nuclear or hazardous substances from Gentilly-2 that posed an unreasonable risk to the environment in 2005.

1.5.7 Radiation Protection

Site	SAFETY AREA	Grades	
		Program	Implementation
Gentilly-2	RADIATION PROTECTION	B	B

In 2004 and 2005, several initiatives with regard to the Radiation Protection program were conducted by Hydro-Québec to address ongoing issues. In 2005, CNSC staff followed-up with Gentilly-2 by focusing on the *action items* raised from the *type I inspection* in 2004 and follow-up *type II inspections*. Based on document reviews, observations, and information exchanges with personnel at Hydro-Québec, CNSC staff concluded that implementation of Radiation Protection now meets CNSC expectations.

1.5.8 Site Security

The assessment of the Site Security safety area for Gentilly-2 is documented in a separate (secret) *Commission Member Document* (CMD 06-M35.A).

1.5.9 Safeguards

Site	SAFETY AREA	Grades	
		Program	Implementation
Gentilly-2	SAFEGUARDS	B	B

Programs at Gentilly-2 to help fulfill Canada's obligations with respect to international *safeguards* met the applicable legal requirements and CNSC staff's expectations in 2005.

1.6 POINT LEPREAU

1.6.1 Operating Performance

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Point Lepreau	OPERATING PERFORMANCE	B	B
	Organization & Plant Management	B	B
	Operations	B	B
	Occupational Health & Safety (Non-radiological)	B	B

Both the program and implementation of the Operating Performance safety area at Point Lepreau met the expectations of Canadian Nuclear Safety *Commission* (CNSC) staff. and contributed adequately to the achievement of CNSC's desired outcomes. Point Lepreau operated safely in 2005.

1.6.1.1 Organization and Plant Management

There were no *serious process failures* at Point Lepreau in 2005. The station experienced two spurious activations of shutdown systems in 2005 (included in Table 1).

The financial guarantees provided by New Brunswick (NB) Power Nuclear were considered to be adequate. The various programs established by NB Power Nuclear to manage its activities were adequately integrated.

A new Vice-President of NB Power Nuclear was formally appointed in May 2005 following the retirement of the previous Vice-President. In another development, the Mechanical Maintenance Superintendent was authorized to act as the Station Manager should the incumbent Station Manager be unavailable.

1.6.1.2 Operations

CNSC staff conducted several field and control room inspections during 2005. There were no major findings and all minor findings were reported to the duty Shift Supervisor for correction.

In 2005, NB Power Nuclear developed and issued a station instruction on managing forced outages. This corrected a long-standing deficiency in Point Lepreau's outage management program, which previously only covered planned outages.

1.6.1.3 Occupational Health and Safety (Non-radiological)

The value of the "Accident Severity Rate" performance indicator (PI) at Point Lepreau (0.7 in 2005) compared favourably with the rest of the industry (see Tables 9 and 10). This marked a return to the historically low value of the PI at Point Lepreau (see also Table 11). Overall, the Occupational Health and Safety program and its implementation met CNSC performance expectations.

1.6.2 Performance Assurance

Site	SAFETY AREA Program	Grades Program	 Implementation
Point Lepreau	PERFORMANCE ASSURANCE	B	B
	Quality Management	B	B
	Human Factors	C	C
	Training, Examination, and Certification	B	B

Both the program and implementation of the Performance Assurance safety area at Point Lepreau met CNSC staff's expectations and contributed adequately to the achievement of the CNSC's desired outcomes in 2005.

1.6.2.1 Quality Management

In response to a concern raised by the CNSC that NB Power Nuclear's current five-year cycle for internal assessment of Canadian Standards Association (CSA) N286 requirements was inadequate, NB Power Nuclear reduced the period to three years.

An inspection of dosimetry services in 2005 revealed some discrepancies with the control of records, shelf-life control within the health physics laboratory, and the calibration of laboratory equipment. *Type I inspections* of Quality Management implementation identified deficiencies in the effectiveness of quarantining nonconforming documents, the consistent use of in-hand procedures, and reporting of the non-conformance of inadequate procedures. However, all deficiencies that were found were being properly managed and corrected by the licensee. The general conclusion from the inspections was that Quality Management was being implemented as documented and that the overall performance of the processes was satisfactory.

1.6.2.2 Human Factors

NB Power Nuclear's Human Factors program continued to evolve in 2005. A strength observed by CNSC staff was the synthesis of information about human performance issues from a variety of sources by the Independent Assessment Group. A process for systematically incorporating human factors into design changes was developed by NB Power Nuclear in 2005 and was formally issued in January 2006. The implementation of the process has not yet been evaluated by CNSC staff.

Although CNSC staff recognizes improvements made at Point Lepreau in 2005, concerns exist in the area of staffing. NB Power Nuclear plans to improve the minimum shift complement by investigating options for reducing reliance on operational staff for emergency response.

NB Power Nuclear reduced the number of staff by approximately 12% (98 positions) in 2003 and 2004. Approximately half of the affected positions were filled by temporary or casual staff. In response to the reduction in staffing levels, CNSC staff conducted an inspection to determine whether NB Power Nuclear has processes in place to ensure that staff with the required skills are currently available and will be available in the future. CNSC staff found that NB Power Nuclear has a documented process to identify and justify the engineering and technically-based skills required to support safe operation of the station. However, this process has not been fully implemented. CNSC staff continues to monitor NB Power Nuclear's implementation of these succession management processes.

1.6.2.3 Training, Examination, and Certification

Two certified staff training programs were evaluated at Point Lepreau in 2005: the initial simulator training program for Shift Supervisors and the continuing training program for certified staff. Also, a non-certified staff training program (for the Chemistry Department and the Health Physics Laboratory) was evaluated at Point Lepreau in 2005 as part of an integrated *type I inspection* of environmental protection policies and procedures (see Section 1.6.6).

Although the evaluations in 2005 identified some deficiencies, progress was made by Point Lepreau to fulfill its corrective action commitments in the training programs for certified and non-certified staff and the requalification testing program. In addition, the success rate in certification examinations at Point Lepreau was adequate.

1.6.3 Design and Analysis

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Point Lepreau	DESIGN AND ANALYSIS	B	B
	Safety Analysis	B	B
	Safety Issues	B	B
	Design	B	B

Both the program and implementation of the Design and Analysis safety area at Point Lepreau met CNSC staff's expectations and contributed adequately to the achievement of the CNSC's desired outcomes in 2005. CNSC staff reviews concluded that the licensee continued to provide acceptable safety analyses and responses to new design and safety issues.

1.6.3.1 Safety Analysis

CNSC staff reviews confirmed that NB Power Nuclear performed acceptable safety analysis in 2005 and made adequate progress toward updating its safety report. NB Power Nuclear's funding of research programs and its monitoring and assessment of new information and research findings to ensure the validity of the safety analysis were considered satisfactory.

1.6.3.2 Safety Issues

CNSC staff reviewed the progress made by the various industry teams to resolve the generic action items (GAI). NB Power Nuclear continued to participate on the teams and the overall progress toward resolution of the GAIs was satisfactory. For more details on particular safety issues, see Appendix E for developments in each GAI in 2005.

1.6.3.3 Design

In 2005, CNSC staff acknowledged NB Power Nuclear's progress in concluding several activities related to the design configuration management backlog project. The project included three components: the design flowsheet reconstitution project, the jumper removal backlog project, and the change proposal and approval and design revision record backlog projects.

CNSC staff performed one *type II* fire protection *inspection*, two field walkdowns for familiarization, and two promotional meetings in 2005. The findings indicated that Point Lepreau was not fully compliant with the fire protection requirements in its licence. A number of non-compliances were identified that contributed to weakness in fire protection provisions at the facility. The weakness, in almost all review areas, was primarily due to the lack of integration of the fire hazard analysis and incomplete inspection, testing and maintenance program elements.

The nature of the non-compliances require effective corrective action in the short term (less than one year) to medium term (one to five years) to prevent unreasonable risk to persons and the environment from fires at the facility. The licensee has initiated corrective actions to address the implementation issues and CNSC staff concludes that the corrective actions to-date have been effective. The corrective actions will continue until the start of the reactor refurbishment outage in 2008.

Based on the above, fire protection is considered to be below requirements for Point Lepreau. This assessment was reported as a separate program grade in the recent licence renewal CMD for Point Lepreau (CMD 06-H4). Aside from the deficiencies in fire protection, which is only one element of the Design program, CNSC staff judges that the overall Design program and its implementation at Point Lepreau met expectations in 2005.

1.6.4 Equipment Fitness for Service

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Point Lepreau	EQUIPMENT FITNESS FOR SERVICE	B	B
	Maintenance	B	B
	Structural Integrity	C	C
	Reliability	B	B
	Equipment Qualification	B	B

Both the program and implementation of the Equipment Fitness for Service safety area at Point Lepreau met CNSC staff's expectations and contributed adequately to the achievement of the CNSC's desired outcomes in 2005.

1.6.4.1 Maintenance

Point Lepreau has policies, processes and procedures in place that provide direction and support for its maintenance program. Point Lepreau's management system process model includes core processes and sub-tier processes that are designed to meet the needs of its maintenance program. The program is supported by a significant organization with established goals. Continuous status reporting and internal audits are done to track whether or not the goals are being met and to look for areas of improvement.

Overall, the Maintenance program at Point Lepreau met regulatory requirements in 2005.

1.6.4.2 Structural Integrity

In 2004, CNSC staff raised some concerns regarding the updating of periodic inspection programs at Point Lepreau. The programs for containment appurtenances were up-to-date with the latest standard revision, but the program for the heat transport and safety system pressure boundaries was out-dated. NB Power Nuclear submitted the revised periodic inspection program in December 2005. Pending the review of the submission by CNSC staff, the Structural Integrity program and its implementation were judged to remain below requirements.

Point Lepreau's periodic inspection programs for *pressure tubes* (PT), *steam generator* (SG) tubes, and *feeder* pipes have now progressed beyond the original construction code acceptance limits and have advanced to fitness-for-service guidelines and aging management programs.

In early 2005, NB Power Nuclear provided CNSC staff with the results of an assessment of PT susceptibility to hydride blisters. NB Power Nuclear concluded that all fuel channels in Point Lepreau are considered to have a low risk of blister formation prior to the outage planned for April 2006, when a spacer location and relocation inspection is scheduled.

Feeder inspections were conducted during the 2005 planned maintenance outage and crack "indications" were found on seven *feeder* bends. All *feeders* with indications were replaced during the outage. See Section D.7.2 for more details.

In January 2005, Point Lepreau added supplementary activities to its *feeder* life cycle management plan to address concerns related to inlet *feeder* integrity. Point Lepreau staff also conducted a thorough engineering assessment of the integrity of inlet *feeders* and concluded that the risk from degradation of inlet *feeders* is very low, and confirmed the validity of the *feeder* life cycle management plan.

NB Power Nuclear recently completed a probabilistic safety evaluation to quantify the risks of *feeder* cracking. NB Power Nuclear concluded that *feeder* cracking will have an acceptably small effect on nuclear safety at Point Lepreau until the planned 2008 refurbishment outage, given 100% annual inspection of tight radius bends on outlet *feeders*. This evaluation is currently being reviewed by CNSC staff.

CNSC staff concludes that NB Power Nuclear's action plan for continued assessment of *feeder* piping degradation, and its approach to managing *feeder* aging issues at Point Lepreau, is satisfactory.

NB Power Nuclear completed a life assessment study of the SGs that concluded that the overall condition of the components appeared to be good. The study provided several recommendations to ensure reliable operation until 2033. Additional inspections were planned for the 2006 and 2007 maintenance outages and the refurbishment outage.

1.6.4.3 Reliability

In 2005, NB Power Nuclear continued to implement the requirements in the new regulatory standard S-98 ("Reliability Programs for Nuclear Power Plants"). The plans for compliance were developed consistently with the industry approach.

NB Power Nuclear's Reliability program is well planned and maintained. Staffing, processes, procedures, and tools are satisfactory. The ability of systems that are important to safety to perform as intended met regulatory requirements in 2005, although CNSC staff is following up on some instances of unavailability of certain safety systems (notably, the Class III standby power).

In 2005, NB Power Nuclear made good progress in developing its probabilistic safety assessment, which is a requirement for its upcoming refurbishment outage.

1.6.4.4 Equipment Qualification

In 2005, CNSC staff inspected the Point Lepreau *environmental qualification* (EQ) program. Both the program and its implementation met the intent associated with CNSC's acceptance criteria. The inspection team identified some areas that require improvement: updating of EQ-related documents (including governing documents, EQ assessments, etc.), definition of roles and responsibilities of EQ and system specialists, development and implementation of environmental and condition monitoring subprograms, and timely completion of corrective actions. NB Power Nuclear promptly initiated 14 corrective actions in response.

NB Power Nuclear completed the scanning and identification of one type of cable insulation to address traceability issues raised by CNSC staff. NB Power Nuclear determined that a number of these cables will be replaced during the 2006 outage. CNSC staff was satisfied with the resolution of this issue.

1.6.5 Emergency Preparedness

Site	SAFETY AREA	Grades	
		Program	Implementation
Point Lepreau	EMERGENCY PREPAREDNESS	A	B

Several initiatives to improve the implementation of the emergency preparedness and response program at Point Lepreau were completed by NB Power Nuclear to address issues previously raised by the CNSC. Based on document review, observations, and exchanges of information with emergency preparedness personnel at Point Lepreau in 2005, CNSC staff concluded that the implementation of the Emergency Preparedness program now meets CNSC expectations.

1.6.6 Environmental Protection

Site	SAFETY AREA	Grades	
		Program	Implementation
Point Lepreau	ENVIRONMENTAL PROTECTION	B	B

The Environmental Protection program and its implementation at Point Lepreau met CNSC expectations in 2005. Both airborne emissions and liquid releases of nuclear substances to the environment were below the *derived release limits* in 2005. Therefore, the estimated radiation doses to the public were well below the regulatory limits. There were no unplanned releases of nuclear substances or hazardous substances from Point Lepreau that posed an unreasonable risk to the environment.

CNSC staff conducted a *type I inspection* of Point Lepreau's environmental protection policies and procedures in March 2005. The inspection identified several strengths as well as areas that required some improvement. The deficiencies were satisfactorily addressed by NB Power Nuclear.

1.6.7 Radiation Protection

Site	SAFETY AREA	Grades	
		Program	Implementation
Point Lepreau	RADIATION PROTECTION	B	B

No worker at Point Lepreau received doses in excess of the regulatory limits in 2005. CNSC staff concluded that operations in 2005 did not pose unreasonable radiation-related risks to workers. Point Lepreau continued to meet the implementation requirements of all elements of the Radiation Protection program in 2005.

In 2004, Point Lepreau modified its personnel respiratory protection program to include protection from radiological hazards in accordance with the relevant CSA standard. The revised documents were reviewed and accepted by CNSC staff in January 2005.

CNSC staff conducted a follow-up visit of the Point Lepreau Radiation Protection program in July 2005. The scope of this visit was to obtain a status update for the program and to follow up on remaining remedial actions from a previous *type I inspection*. No major concerns were identified, although CNSC staff noted problems with the implementation of the ALARA (as low as reasonably achievable) program.

1.6.8 Site Security

The assessment of the Site Security safety area for Point Lepreau is documented in a separate (secret) *Commission Member Document* (CMD 06-M35.A).

1.6.9 Safeguards

Site	SAFETY AREA	Grades	
		Program	Implementation
Point Lepreau	SAFEGUARDS	B	B

In 2005, programs at Point Lepreau to help fulfill Canada's obligations with respect to international *safeguards* met the applicable legal requirements and expectations of CNSC staff.

There were two noteworthy developments at Point Lepreau in 2005. First, an unplanned power outage resulted in a partial loss of lighting in areas under *International Atomic Energy Agency* (IAEA) surveillance. The IAEA was immediately notified and was able to verify that the surveillance data from the areas with reduced lighting was still acceptable.

Second, damage to IAEA surveillance equipment caused by an improper electrical connection was corrected. IAEA technicians installed new camera equipment and restored system functionality. The IAEA later confirmed that some data was lost, but the implications of this finding are yet-to be determined by the IAEA.

SECTION 2

SAFETY PERFORMANCE AND TRENDS ACROSS THE INDUSTRY

This section of the report discusses overall safety performance at the stations. The discussion is organized according to the safety areas and programs. The definitions of the safety areas and programs follow the Introduction of the report. Year-to-year trends are illustrated and significant issues that pertain to the industry at large are highlighted. Canadian Nuclear Safety *Commission* (CNSC) performance indicators (PIs) are used to illustrate various trends and issues. Their definitions are taken from regulatory standard S-99 ("Reporting Requirements for Operating Nuclear Power Plants").

2.1 OPERATING PERFORMANCE

The 18 reactors that were operational in 2005 were in a *guaranteed shutdown state* (GSS) approximately 16% of the time. The value would be 14% if one excluded the first two quarters of 2005 when Pickering A Unit 1 was in GSS prior to its restart. At Pickering A, Unit 4 also operated in 2005, but Ontario Power Generation (OPG) announced that it would not proceed with the restart of Units 2 and 3 (see Section D.4.6). Bruce A Units 1 and 2 are currently in a *lay-up state* while an environmental assessment for their potential restart continues.

2.1.1 Organization and Plant Management

Licensees had appropriate organizations to manage and safely operate their stations in 2005.

No worker at any station or member of the public received a radiation dose in excess of the regulatory limits in 2005. Emissions from all plants were also well below regulatory limits. Low personnel radiation exposures and environmental emissions continued to be the norm for the industry in 2005. These results are general reflections of adequate controls employed by the organizations at the sites.

There were no *serious process failures* at any station in 2005.

CNSC staff uses *action items* to bring issues that require timely, corrective action to the attention of licensees. In 2005, CNSC staff opened a total of 72 *action items* and closed 80. A total of 261 *action items* were open at the end of 2005. CNSC staff was satisfied with licensees' *action item* management, event reporting, plant system performance analysis, and follow-up. There were 701 reportable events at the stations in 2005; the most important ones are among the significant developments described in Appendix D. In addition, CNSC staff continued to observe a low self-reporting threshold, indicative of a positive, questioning attitude of licensee staff.

The purpose of the "Number of Unplanned Transients" performance indicator (PI) is to indicate the number of reactor power transients due to equipment failures or operator errors while the reactor is not in a GSS. This PI shows the number of manual or automatic power reductions from actuation of the shutdown, *stepback* or *setback* systems (note that Pickering A does not have a *stepback* system). Unexpected power reductions may be indicative of problems within the plant and may place unnecessary strain on systems. The "Number of Unplanned Transients" PI is illustrated in Tables 1, 2 and 3. Most of the unplanned transients in 2005 were *setbacks*, which typically pose little risk to plant operations. The significant transients are described in the *Commission Member Documents* (CMD) known as Significant Development Reports (SDR; see Appendix D).

The PI also includes the number of hours that the reactors were in a GSS. Note that GSS hours are only reported in Tables 1 and 2 in 2004 and 2005 for reactors that were not in the *lay-up state*. For the years 2001 to 2003, GSS hours are summed for all reactors, including those in the *lay-up state*.

Table 1: Number of Unplanned Transients for 2005

Station	GSS Hrs	Unplanned Transients at Sites in 2005			
		Trips	*Stepbacks*	*Setbacks*	Total
Bruce A	2664.9	3	0	22	25
Bruce B	3997.2	2	3	2	7
Darlington	2223	1	1	2	4
Pickering A	8279	2*	NA	1	3
Pickering B	6240	2	0	7	9
Gentilly-2	1197	1	1	1	3
Point Lepreau	932	2	0	0	2
Total for Industry	25533	13	5	35	53

*one of the trips at Pickering A occurred while the reactor was sub-critical

Tables 2 and 3 show the trends of this PI for the industry since 2001. For the entire industry in 2005, the number of transients was somewhat larger than previous years. The increase can be attributed mostly to the large number of *setbacks* at Bruce A and, to a lesser extent, Pickering B. Most of the *setbacks* at Bruce A were due to a noisy channel signal (see Section 1.1.1.1 for more details). In 2005, there was an industry average of 9200 hours of non-GSS time between reactor trips or *stepbacks*. The international performance target is one reactor trip per 7000 hours of operation.

Table 2: Trend Details of Number of Unplanned Transients for Industry

Year	GSS Hrs	Unplanned Transients in Industry			
		Trips	*Stepbacks*	*Setbacks*	Total
2001	41341	6	5	10	21
2002	51503	3	1	13	17
2003	47922	19	13	11	43
2004	20424 *	10	5	22	37
2005	25533 *	13	5	35	53

*For 2004 and 2005, GSS hours were only tabulated for reactors not in a *lay-up state*.

Table 3: Trends of Number of Unplanned Transients for Stations

Station	Unplanned Transients				
	2001	2002	2003	2004	2005
Bruce A	NA	NA	1	17	25
Bruce B	3	6	8	4	7
Darlington	5	1	10	6	4
Pickering A	NA	NA	7	4	3
Pickering B	12	6	14	3	9
Gentilly-2	0	2	2	1	3
Point Lepreau	1	2	1	2	2
Total for Industry	21	17	43	37	53

2.1.2 Operations

Most inspections conducted by CNSC staff at the stations in 2005 confirmed compliance with CNSC requirements and the licensees' governing procedures and documents, and did not require any remedial action. For those inspections that required remedial action, CNSC staff generally found that the licensees implemented appropriate measures to correct the deficiencies.

The purpose of the "Unplanned Capability Loss Factor" PI in Tables 4 and 5 is to indicate how a unit is managed, operated, and maintained in order to avoid unplanned outages. The PI is the percentage of the reference electrical output for the station that was lost during the period due to unplanned circumstances. Some of the unplanned shutdowns for the stations are described in Appendix D. In addition to being an economic indicator, the PI is a reflection of overall management of the plant. This factor was particularly high for Pickering A in 2005 (see Table 4), and can be attributed almost entirely to unplanned shutdowns at Unit 4. A relatively high loss factor is typical of units at stations that have returned from long *lay-ups*, which was the case for Unit 4. Table 5 indicates that Pickering A had a high loss factor in 2004 as well. Table 5 shows that Bruce B had a modest increase in 2005, whereas the factor decreased significantly in 2005 for Bruce A, Pickering B, Darlington, and Gentilly-2.

Table 4: Unplanned Capability Loss Factor for 2005

Station	Unplanned Capability Loss Factor (%)				
	Quarter				For Year
	Q1	Q2	Q3	Q4	
Bruce A	1.0	9.1	8.4	4.1	5.7
Bruce B	5.5	15.2	3.8	9.4	8.5
Pickering A	0.2	98.1	21.4	11.4	30.1
Pickering B	1.9	3.1	6.9	8.4	5.1
Darlington	2.2	4.0	4.0	3.4	3.4
Gentilly-2	0.0	4.6	0.0	0.7	1.3
Point Lepreau	1.0	22.0	3.2	0.5	6.6

Table 5: Trend Details of Unplanned Capability Loss Factor for Industry

Station	Unplanned Capability Loss Factor (%)				
	Year				
	2001	2002	2003	2004	2005
Bruce A				11.4	5.7
Bruce B	1.3	6.4	3.8	4.9	8.5
Pickering A				18.5	30.1
Pickering B	9.6	7.2	19.1	12.2	5.1
Darlington	5.6	4.9	4.3	6.7	3.4
Gentilly-2	0.0	0.0	0.2	10.2	1.3
Point Lepreau	14.3	9.2	3.9	6.9	6.6

In 2005, there were 11 planned shutdowns for routine outages of the operating reactors, lasting a total of 854 days. In general, CNSC staff found that the planning and performance of outages was acceptable.

The purpose of the "Non-Compliance Index" PI is to indicate the number of occurrences where the operation of the station failed to comply with its licence conditions or with the Nuclear Safety and Control Act (NSCA) and Regulations. All non-compliances are evaluated by CNSC staff. Non-compliances are categorized as follows:

a = number of non-compliances with the operating policies and principles that are referenced in the licence;
b = number of non-compliances with the radiation protection requirements that are referenced in the licence;
c = number of non-compliances with the minimum shift complement that are referenced in the licence;
d = number of other non-compliances with the licence; and
e = number of non-compliances with the NSCA and Regulations.

Tables 6, 7 and 8 illustrate the "Non-Compliance Index" PI for the industry. The stations had comparable numbers of non-compliances in 2005 (Table 6). The total number of non-compliances for the industry continued to decrease in 2005 (Table 7), with the largest decrease at Pickering (Table 8). (Prior to 2004, this PI was not reported separately for Pickering A and B.) Note that the non-compliances are relative to the different requirements at each site, including different operating policies and principles, radiation requirements, designs, licence conditions, and practices.

Table 6: Non-Compliance Index for 2005

Station	Non-Compliances by Type					
	a	b	c	d	e	Total
Bruce A	3	22	4	39	1	69
Bruce B	3	35	14	30	4	86
Pickering A	39	19	0	33	1	92
Pickering B	14	31	2	32	2	81
Darlington	29	35	3	14	1	82
Gentilly-2	5	1	0	0	0	6
Point Lepreau	2	1	1	8	10	22

Table 7: Trend Details of Non-Compliance Index for Industry

Year	Non-Compliances by Type					
	a	b	c	d	e	Total
2001	239	161	3	169	17	589
2002	219	140	13	222	24	618
2003	142	186	10	203	50	591
2004	108	167	20	142	36	473
2005	95	144	24	156	19	438

Table 8: Trends of Non-Compliance Index for Stations

Station	Total Non-Compliances				
	2001	2002	2003	2004	2005
Bruce A	9	24	120	81	69
Bruce B	123	124	79	72	86
Pickering	295	337	282	202	173
Darlington	110	58	70	71	82
Gentilly-2	18	20	13	23	6
Point Lepreau	34	55	27	24	22
Total for Industry	589	618	591	473	438

2.1.3 Occupational Health and Safety (Non-radiological)

All licensees met the expectations for Occupational Health and Safety at all sites in 2005. The "Accident Severity Rate" PI is used to monitor licensee performance in meeting nuclear industry standards in the area of worker safety (see Tables 9, 10 and 11). The PI measures the total number of days lost to injury for every 200,000 person-hours worked at the site. (Caution is advised when comparing licensees due to the differences among organizations, including the definitions of industrial accidents, jurisdiction of worker safety, and the interpretation of lost time associated with chronic health problems.)

The Accident Severity Rates for the licensees in 2005 were generally lower than previous years (Table 11), particularly at Point Lepreau where the rate returned to a more typical value for that site. The number of lost time accidents at the various sites continued to be well below that of other comparable industries, as well as the latest published statistical average (2002) for federal public service departments. CNSC staff considers that the occupational safety statistics of the industry as a whole continued to be strong in 2005.

Table 9: Accident Severity Rate for 2005

Site	Days Lost	Person Hours	Accident Severity
Bruce A & B	29	6613590	0.9
Pickering A & B	86	8654241	2.0
Darlington	24	4629794	1.0
Gentilly-2	26	1452714	3.6
Point Lepreau	5	1348021	0.7
Industry Total	170	22698360	1.50

Table 10: Trend Details of Accident Severity Rate for Industry

Year	Days Lost	Person Hours	Accident Severity
2001	468	19514814	4.80
2002	350	17579865	3.98
2003	372	16612884	4.48
2004	145	16447399	1.76
2005	170	22698360	1.50

Table 11: Trends of Accident Severity Rate for Stations

Site	Accident Severity Rate				
	2001	2002	2003	2004	2005
Bruce A & B	9.7	4.8	4.2	0.0	0.9
Pickering A & B	0.7	1.4	3.7	0.0	2.0
Darlington	0.7	0.0	0.6	3.0	1.0
Gentilly-2	18.0	25.2	20.4	1.2	3.6
Point Lepreau	8.5	0.0	0.1	14.2	0.7

2.2 PERFORMANCE ASSURANCE

There were significant developments in 2005 in the Performance Assurance safety area. All licensees continued to work toward developing, maintaining, and implementing adequate programs for Quality Management, Human Factors, and Training, Examination, and Certification. Progress was made at Darlington and Pickering A and B, where all the programs under the safety area, and their implementation, now meet CNSC expectations. However, more work remains before all the programs under Performance Assurance can meet requirements and be adequately implemented at Bruce A and B, Gentilly-2, and Point Lepreau. CNSC staff continues to monitor this safety area to assure that the weaknesses are not manifested in the form of safety problems at these stations.

2.2.1 Quality Management

The multi-unit OPG stations (Darlington and Pickering A and B) have a documented Quality Management program that continued to meet requirements in 2005. OPG took action to correct discrepancies in its management oversight and leadership, specifically in the areas of self-assessment and independent assessments. Implementation of the Quality Management at all the OPG stations improved in 2005 and is now considered to meet CNSC expectations.

At Bruce A and Gentilly-2, implementation of Quality Management is now considered to below requirements—a lack of procedural adherence was cited as one of the weaknesses at both stations.

CNSC staff continues to monitor this program closely to ensure that safe operations are supported by adequate Quality Management systems at all stations.

2.2.2 Human Factors

The state of the processes required to meet CNSC staff's expectations for Human Factors programs across the industry ranges from currently acceptable to progressing towards an acceptable state. Progress is still required for the implementation of these processes for Bruce A and B, Point Lepreau, and Gentilly-2.

CNSC staff observed continued progress and increased visibility of various Human Factors initiatives at all sites in 2005. An achievement in 2005 was the formalization of timeframes for improvements in certified staffing levels at multi-unit stations.

In 1997, the Integrated Improvement Plan recommended eliminating the use of non-certified staff to monitor the control panels of the reactor units operated at that time by Ontario Hydro. OPG and Bruce Power have submitted staffing plans biannually since 2000 to show progress in meeting staffing targets for Authorized Nuclear Operators (ANO). In March 2003, CNSC staff advised OPG and Bruce Power that they were expected to have an ANO at the control panels of each reactor unit at all times by March 1, 2005, and that this commitment would be formalized in future operating licence conditions.

When the Bruce A licence was amended to allow the restart of Unit 4 in 2003, and when the Bruce B licence was renewed in 2004, the following condition was included: “Beginning March 1, 2005, there shall be at all times for each reactor unit, an Authorized Nuclear Operator in direct attendance at the reactor unit’s main control room control panels”. In 2005, Bruce Power requested licence amendments to delay the implementation of this condition until October 1, 2009 f Bruce A and October 1, 2007 for Bruce B. The committed date for Bruce A is based on having two units in operation. CNSC staff confirmed Bruce Power’s plans to meet these deadlines before amending the licences.

In 2005, the Pickering A licence was amended to require an ANO at the reactor units’ main control room panels at all times. At the remaining OPG stations, there will not be adequate staffing to have an ANO at the control panels of each reactor unit at all times until July 31, 2007 and July 31, 2009 for Pickering B and Darlington, respectively.

As an interim measure at Bruce A, Bruce B, Pickering B and Darlington, the amended licences also include conditions that limit and control the use of non-certified operators at the control panels of a reactor and that increase the minimum number of ANOs required in the station and in the main control room.

In 1998, Ontario Hydro initiated a shift re-organization at its stations by introducing the position of Control Room Shift Supervisor to replace the Control Room Shift Operating Supervisor. In 2005, Bruce Power’s operating licences were amended to document the regulatory requirements associated with the introduction of the new position. The new position was introduced at Darlington prior to 2005, but Pickering A and B have not yet completed this initiative.

2.2.3 Safety Culture and Safety Management

During 2005, a safety culture workshop was held with the industry as part of the CNSC’s ongoing commitment to develop guidelines for licensee self-assessments and encourage licensees to foster a strong safety culture at their respective facilities.

Future work in the area of safety culture will include a more integrated focus on safety management and on the importance of integrating safety culture into all CNSC regulatory activities to ensure high levels of safety performance at licensed facilities.

2.2.4 Training, Examination, and Certification

Although evaluations conducted during 2005 identified some deficiencies, progress is being made at all sites to fulfill the corrective action commitments in the Training, Examination and Certification program. CNSC staff continues to monitor this program closely to ensure that all stations have adequately trained staff to support safe operation.

In 2005, two non-certified staff training programs were evaluated across all OPG stations: 1) initial training for mechanical maintainers and 2) initial training for control maintainers.

2.3 DESIGN AND ANALYSIS

2.3.1 Safety Analysis

Updates of the safety report for each site are required once every three years in accordance with the operating licenses. The most important performance expectation is the need to monitor and assess the impact on safety analysis of operating transients, plant changes due to aging, and sustained loss of heat sink scenarios. For the year 2005, CNSC staff reviews confirmed that all licensees performed acceptable safety analyses.

2.3.2 Safety Issues

There has been progress on some outstanding safety issues in 2005, while progress on others proved to be slower than anticipated. Thirteen generic action items (GAIs) were active in 2005; one of them was closed (GAI 98G01) and no new GAIs were created. Progress on each of the GAIs is described in Appendix E. CNSC staff is satisfied that adequate progress was made on the remaining safety issues by all licensees.

2.3.3 Design

In 2005, CNSC staff reviews indicated that the fire protection program and implementation at some plants have weaknesses. CNSC staff identified findings from previous inspections that have not been addressed, resulting in non-compliance with the fire protection requirements of the operating licences. Other aspects of the Design program were satisfactory at the stations in 2005, with the exception of the lack of resolution of Design issues identified at Pickering B following the August 2003 blackout.

2.4 EQUIPMENT FITNESS FOR SERVICE

In 2005, CNSC staff reviews showed that the licensees met, in principle, the requirements for programs in the area of Equipment Fitness for Service. However, implementation of those programs did not meet requirements in some cases.

2.4.1 Maintenance

All licensees have established maintenance programs to meet their maintenance program licence conditions. The general objective of these programs is to ensure that systems, structures and components continue to be capable of fulfilling their design intent. A major element of these programs is work management including preventive, elective, and corrective maintenance work orders.

In 2005, the completion of maintenance backlogs continued to be a challenge for most of the licensees, CNSC staff remains concerned with the high level of backlogs. However, the licensees are making progress in reducing the outstanding work. CNSC staff continues to monitor this area and expects licensees to set backlog targets and review their effectiveness at meeting them.

2.4.2 Structural Integrity

In 2003, CNSC staff requested that Bruce Power acquire a certificate of authorization which includes plans and procedures to implement quality assurance (QA) programs for pressure boundaries according to the applicable standards. Bruce Power extended the implementation schedule of the QA program until December 2006. Since November 2005, CNSC staff and Bruce Power staff have met quarterly to discuss the progress in the implementation of the pressure boundary program.

Pressure-retaining components at Darlington and Pickering are operated and maintained under accepted QA programs with a certificate of authorization.

In 2005, CNSC staff reviewed the documentation in Hydro-Québec's QA system related to pressure boundary work. Hydro-Québec's application for a certificate of authorization for pressure boundary work is currently being reviewed by the provincial authority.

Point Lepreau continues to use contractors to perform pressure boundary work.

Through participation in Canadian Standards Association (CSA) technical committees, CNSC staff and the industry have been involved in reviewing and updating existing standards to provide a more risk-informed approach for the repair, replacement, and modification of pressure retaining systems and components. CNSC staff provided support in the final update of CSA N285.0 standard leading to the publication of the 2006 edition.

The licensees have aging and life-cycle management strategies and plans for fuel channels to help prevent failures. These plans summarize the current understanding of degradation mechanisms that affect *pressure tubes* (PT), based on research and development programs and assessments of earlier data collected at CANDU reactors. The plans describe the inspection and maintenance activities intended to manage the observed degradation mechanisms and any possible future degradation.

CNSC staff is satisfied that Bruce Power, OPG, and Hydro-Québec have implemented a managed process and a firm technical basis for assessing PT fitness for service. CNSC staff is also satisfied that Bruce Power and OPG view their plans as "triggers" for future action. Since Hydro-Québec only issued its new fuel channel aging and life cycle management plan in September 2005, it is too early to assess the adequacy of its implementation at Gentilly-2.

The fuel channel life management and inspection program for Point Lepreau was issued in 2000 and its implementation is ongoing. However, the program requires updates to reflect advances in technology and current standards for managing fuel channel structural integrity. NB Power Nuclear recently initiated a heat transport system life cycle management plan improvement project to systematically review all the programs and procedures relevant to maintaining the structural integrity of fuel channels, as well as *feeders* and *steam generators*.

In 2005, Bruce Power and OPG recognized that a number of PTs at Bruce B and Darlington were exhibiting similar oxidation phenomena. Bruce Power and OPG agreed to a cooperative investigation and to communicate the results to CNSC staff in early 2006.

During the Unit 2 inspection outage, Darlington voluntarily removed a PT to support the industry assessment of the impact of irradiation on critical material properties. Darlington submitted the acceptance criteria they intend to apply to the destructive examination of this tube to CNSC staff.

In 2005, CNSC staff raised a concern regarding the increased number and severity of PT crevice corrosion flaws in the recently inspected PTs in a number of stations. CNSC staff requested that OPG conduct, in collaboration with all the affected and interested utilities and research and development organizations, a thorough review of all related issues to ensure that adequate provisions are provided to effectively manage this form of degradation.

The licensees, through the CANDU Owner's Group, have been developing new fitness-for-service guidelines to deal with the highly localized *feeder* wall thinning near welds. The new fitness-for-service guidelines are expected to be issued in 2006.

The purpose of the "Number of Pressure Boundary Degradations" PI is to indicate the number of pressure boundary degradations that have occurred at the stations and to monitor the performance in meeting nuclear industry codes and standards. Degradations are defined as instances where limits in relevant design or inspection criteria are exceeded. The "class" that is referred to is the code classification of nuclear systems, whereas "conventional" refers to non-nuclear systems. The PI data for the industry is shown in Tables 12, 13 and 14. The number of degradations in 2005 was significantly higher than in previous years (Table 13). However, the decrease in the number of degradations at Pickering A and B and Point Lepreau, from 2004 to 2005, was noteworthy (Table 14). For all stations, the vast majority of the degradations occurred in the conventional systems.

Table 12: Pressure Boundary Degradations for 2005

Station	Number of Pressure Boundary Degradations by Type					
	Class 1	Class 2	Class 3	Class 4	Conv	Total
Bruce A	7	0	5	0	80	92
Bruce B	20	6	5	1	174	206
Darlington	16	7	10	0	59	92
Pickering A	0	0	0	0	4	4
Pickering B	3	0	6	0	34	43
Gentilly-2	0	0	0	0	0	0
Point Lepreau	1	0	1	0	1	3

Table 13: Trend Details of Pressure Boundary Degradations for Industry

Year	Number of Pressure Boundary Degradations by Type					
	Class 1	Class 2	Class 3	Class 4	Conv	Total
2001	24	9	30	1	281	345
2002	18	11	37	0	261	327
2003	37	10	28	1	333	409
2004	21	4	23	0	292	340
2005	47	13	27	1	352	440

Table 14: Trends of Pressure Boundary Degradations for Stations

Station	Total Number of Pressure Boundary Degradations				
	2001	2002	2003	2004	2005
Bruce A	21	18	131	68	92
Bruce B	47	71	109	134	206
Darlington	80	91	59	66	92
Pickering A & B	155	109	100	64	47
Gentilly-2	3	3	0	0	0
Point Lepreau	39	35	10	8	3

2.4.3 Reliability

In early 2006, the licensees applied for licence amendments to include a new condition requiring compliance with regulatory standard S-98 (“Reliability Programs for Nuclear Power Plants”), which was issued in 2005. Based on continuing dialogue with the industry, CNSC staff foresees that the licensees’ programs will satisfy the requirements in the standard.

Overall, the systems important to safety performed well in terms of reliability, although there were events in 2005 that challenged the reliability of some of the *special safety systems*. The availability of electrical systems at Pickering was a concern that CNSC staff continues to monitor.

The purpose of the “Number of Missed Mandatory Safety System Tests” PI is to indicate successful completion of tests required by licence conditions, including those referenced in documents submitted in support of a licence application. This PI represents the ability of licensees to successfully complete routine tests on systems related to safety. Data for this PI is shown in Tables 15, 16 and 17. Approximately 90,000 of these tests were performed throughout the industry in 2005. The total number of missed tests was lower in 2005 than in 2004 (Table 16), due to a significant improvement at Pickering B (Table 17).

The missed mandatory tests continued to be dominated by those related to the *special safety systems* (Table 15). However, the total number of missed tests of the *special safety systems* was much lower compared with last year (Table 16), and represented only an insignificant percentage of the tens of thousands of tests performed in 2005. This indicated a consistent industry commitment to test its safety systems on a regular basis.

Table 15: Missed Mandatory Safety System Tests for 2005

Station	Total # Tests	Missed Mandatory Safety System Tests			
		Special	Standby	Safety Related	Total
Bruce A	17078	4	0	0	4
Bruce B	29825	5	2	0	7
Darlington	10800	0	0	3	3
Pickering A	9700	0	0	0	0
Pickering B	10984	1	0	1	2
Gentilly-2	no data	1	0	0	1
Point Lepreau	5712	0	0	0	0
Total for Industry	84099	11	2	4	17

Table 16: Trend Details of Missed Mandatory Safety System Tests for Industry

Year	Total # Tests	Total Number of Missed Mandatory Safety System Tests			
		Special	Standby	Safety Related	Total
2001	52841	2	0	4	6
2002	63864	3	1	0	4
2003	64303	2	2	3	7
2004	84471	18	3	6	27
2005	84099	11	2	4	17

Table 17: Trend of Missed Mandatory Safety System Tests for Stations

Station	Total Number of Missed Mandatory Safety System Tests				
	2001	2002	2003	2004	2005
Bruce A				2	4
Bruce B	0	0	0	1	7
Darlington	4	0	0	1	3
Pickering A	0	0	0	0	0
Pickering B	2	1	5	19	2
Gentilly-2	0	1	2	2	1
Point Lepreau	0	2	0	2	0
Total for Industry	6	4	7	27	17

2.4.4 Equipment Qualification

The licensees were required by a licence condition on *environmental qualification* (EQ) to establish, by June 30, 2004, that all *special safety systems* and safety support systems were qualified to perform their safety functions under the environmental conditions resulting from their design basis accidents.

In 2005, CNSC staff found that, in principle, the EQ programs and their implementation met the intent of the CNSC criteria. However, some of the licensees reported EQ issues related to the steam-protected rooms, while other licensees needed to complete implementation of the environmental monitoring program and training modules for their staff.

2.5 EMERGENCY PREPAREDNESS

Overall, the industry continued to exceed CNSC requirements and consistently meet CNSC performance expectations for Emergency Preparedness programs. No reportable events had any significant bearing on any of the industry's Emergency Preparedness programs or their implementation.

2.6 ENVIRONMENTAL PROTECTION

In 2005, monitoring data on airborne emissions and liquid releases of radioactive substances for all plants showed releases to the environment were consistently below the *derived release limits*. Doses to the public (in particular, members of the critical groups) were well below regulatory limits based on available data (2004). As in previous years, these results demonstrated a continuing positive trend throughout the industry.

Licensees are required to report to the CNSC any unplanned releases of radioactive material or other hazardous substances to the environment. There were no reported unplanned releases of nuclear substances or hazardous substances from any power reactor sites in 2005 that posed an unreasonable risk to the environment.

2.7 RADIATION PROTECTION

CNSC staff carried out regular reviews of most aspects of Radiation Protection programs at all facilities and found that, in general, licensees continued to adequately manage radiation doses.

In 2005, most licensees worked toward modifying their respiratory protection programs and documented the modifications to ensure conformance with the requirements of the relevant CSA standard. CNSC staff has not yet confirmed that all licensees have completed the implementation of those requirements.

In 2005, most of the stations met the regulatory requirements for implementation of their Radiation Protection programs. Pickering B submitted an action plan for issues raised during a *type I inspection*. Also, Hydro-Québec was on schedule to complete its action plan for issues raised in 2004.

The purpose of the “Radiation Occurrence Index” PI is to indicate the number and weighted severity of radiation occurrences at the station, thus monitoring the performance in meeting the CNSC’s expectations in the area of worker radiation protection. The index and its components are defined and calculated as follows:

a = number of occurrences, after decontamination attempts, of fixed body contamination > 50 kBq/m^2
b = number of occurrences of unplanned acute whole body doses from external exposure > 5 mSv
c = number of occurrences of intake of radioactive material with effective dose > 2 mSv (normalized to 2 mSv)
d = number of occurrences of acute or committed dose in excess of specified limits

Radiation Occurrence Index = a + 5b + 5c + 50d

The “weight” of each component in the formula indicates the relative safety significance of the various types of occurrences. Tables 18, 19 and 20 show the “Radiation Occurrence Index” PI for the industry. In 2005, there were no doses in excess of specified limits (value of “d” in Table 18). For Bruce A and B, Darlington, and Pickering A, no occurrences of any type occurred. For Pickering B, Gentilly-2, and Point Lepreau, the significant increases in the index for 2005 (Table 20) can be attributed to the increase in type ‘c’ occurrences (Tables 18 and 19).

Table 18: Radiation Occurrence Index for 2005

Station	Radiation Occurrence				
	a	b	c	d	Index
Bruce A	0	0	0	0	0
Bruce B	0	0	0	0	0
Darlington	0	0	0	0	0
Pickering A	0	0	0	0	0.0
Pickering B	0	0	3.6	0	18.0
Gentilly-2	0	0	3.4	0	17.1
Point Lepreau	0	0	4.35	0	22

Table 19: Trend Details of Radiation Occurrence Index for Industry

Year	Radiation Occurrence				
	a	b	c	d	Index
2001	1	0	8.8	0	45.2
2002	0	0	4.4	0	22.0
2003	2	0	6.7	0	35.5
2004	0	0	2.1	0	10.4
2005	0	0	11.4	0	56.8

Table 20: Trends of Radiation Occurrence Index for Stations

Station	Radiation Occurrence Index				
	2001	2002	2003	2004	2005
Bruce A	0	0	0	0	0
Bruce B	17	13.2	0.0	5	0
Darlington	0	0	0	0	0
Pickering	0.0	9	0.0	5.4	18.0
Gentilly-2	27.0	0.0	35	0.0	17.1
Point Lepreau	1.0	0.0	0	0	21.8

2.8 SITE SECURITY

The assessment of the Site Security safety area for the industry is documented in a separate (secret) report (CMD 06-M35.A).

2.9 SAFEGUARDS

In 2005, pursuant to the *safeguards* agreements between the Government of Canada and the *International Atomic Energy Agency* (IAEA), IAEA staff performed *safeguards* inspections and other verification activities at all power reactor sites in Canada. In a timely manner, all licensees provided all information necessary for the CNSC to meet its reporting commitments to the IAEA. All licensees cooperated with the CNSC and the IAEA to successfully accomplish routine inspection activities, including design information verification, the annual simultaneous physical inventory verification, complementary accesses, and equipment installations. All licensees promptly addressed any problems or issues that arose. The IAEA has yet to report its final conclusion on the *safeguards* results in Canada for 2005; however, CNSC staff expects a positive result.

2.10 CONCLUSION

The review of the Operating Performance safety area supported the conclusion that the Canadian power reactor industry operated safely in 2005. The PI data for the stations provided further evidence to support the conclusion. The review of the programs in the other eight safety areas confirmed that the licensees had adequate programs in place to support the safe performance of the industry in 2005.

The grades assigned to the licensees for the various safety areas and programs are summarized in the following three tables. Table 21 shows the "program" portion of the safety area grades. Table 22 shows the "implementation" portion of the safety area grades. In both tables, the grades from the two previous annual reports are shown for comparison. Table 23 repeats all the grades for all safety areas in 2005, as well as the grades for all the programs under each safety area.

The absence of 'C' grades in 2005 in Table 21, compared with Table 22, suggests that the licensees generally had good programs for the various safety areas but that they were not always well-implemented.

As in previous years, the industry continued to have well-developed and well-implemented programs in the Emergency Preparedness, Environmental Protection, and Safeguards safety areas. With the improvements at Gentilly-2 under Radiation Protection in 2005, that safety area was also a noteworthy strength for the entire industry.

There were significant developments in 2005 in the Performance Assurance safety area. All licensees continued to work toward developing, maintaining, and implementing adequate programs. Progress was made at Darlington and Pickering A and B, where all the programs under the safety area, and their implementation, now meet CNSC expectations. However, more work remains before all the programs under Performance Assurance can meet requirements and be adequately implemented at Bruce A and B, Gentilly-2, and Point Lepreau.

Table 21 - Trends of "Program" Grades from Annual Reports for the Nine Safety Areas at all Sites

Safety Area	Year of Report	Bruce A	Bruce B	Darlington	Pickering A	Pickering B	Gentilly-2	Point Lepreau
Operating Performance	2003	B	B	B	B	B	B	B
	2004	B	B	B	B	B	B	B
	2005	B	B	B	B	B	B	B
Performance Assurance	2003	B	B	B	B	B	C	C
	2004	B	B	B	B	B	C	B
	2005	B	B	B	B	B	B	B
Design & Analysis	2003	B	B	B	B	C	B	B
	2004	B	B	B	B	B	B	B
	2005	B	B	B	B	B	B	B
Equipment Fitness for Service	2003	B	B	B	B	B	B	B
	2004	B	B	B	B	B	B	B
	2005	B	B	B	B	B	B	B
Emergency Preparedness	2003	A	A	A	A	A	A	A
	2004	A	A	A	A	A	A	A
	2005	A	A	A	A	A	A	A
Environmental Protection	2003	B	B	B	B	B	B	B
	2004	B	B	B	B	B	B	B
	2005	B	B	B	B	B	B	B
Radiation Protection	2003	B	B	A	B	B	A	B
	2004	B	B	B	B	B	B	B
	2005	B	B	B	B	B	B	B
Site Security	2003	Protected						
	2004							
	2005							
Safeguards	2003	A	A	A	A	A	A	A
	2004	B	B	B	B	B	B	B
	2005	B	B	B	B	B	B	B

Program grades for 2005 that changed since the 2004 annual report are highlighted.

Legend:

A = Exceeds requirements	B = Meets requirements	C = Below requirements	D = Significantly below requirements	E = Unacceptable

Table 22
Trends of "Implementation" Grades from Annual Reports for the Nine Safety Areas at all Sites

Safety Area	Year of Report	Bruce		Darlington	Pickering		Gentilly-2	Point Lepreau
		A	B		A	B		
Operating Performance	2003	B	B	B	B	C	B	B
	2004	B	B	B	B	B	B	B
	2005	B	B	B	B	B	B	B
Performance Assurance	2003	B	B	C	C	B	C	C
	2004	B	B	B	B	B	C	B
	2005	C	B	B	B	B	C	B
Design & Analysis	2003	B	B	B	B	C	B	B
	2004	B	B	B	B	C	B	B
	2005	B	B	B	B	C	B	B
Equipment Fitness for Service	2003	B	B	B	B	B	B	B
	2004	B	B	B	B	B	B	C
	2005	B	B	B	B	C	B	B
Emergency Preparedness	2003	A	A	A	A	A	A	C
	2004	A	A	A	A	A	B	C
	2005	A	A	A	A	A	B	B
Environmental Protection	2003	B	B	B	B	B	B	B
	2004	B	B	B	B	B	B	B
	2005	B	B	B	B	B	B	B
Radiation Protection	2003	B	B	B	B	B	C	B
	2004	B	B	B	B	B	C	B
	2005	B	B	B	B	B	B	B
Site Security	2003	Protected						
	2004							
	2005							
Safeguards	2003	A	A	A	A	A	A	B
	2004	B	B	B	B	B	B	B
	2005	B	B	B	B	B	B	B

Implementation grades for 2005 that changed since the 2004 annual report are highlighted.

Legend:

A = Exceeds requirements	B = Meets requirements	C = Below requirements	D = Significantly below requirements	E = Unacceptable

Table 23 - Summary Table of "Program" and "Implementation" Grades for all Safety Areas and Programs at all Sites

Safety Area / Program	P or I	Bruce A	Bruce B	Darlington	Pickering A	Pickering B	Gentilly-2	Point Lepreau
Operating Performance	P	B	B	B	B	B	B	B
	I	B	B	B	B	B	B	B
Organization & Plant Management	P	B	B	B	B	B	B	B
	I	B	B	B	B	B	B	B
Operations	P	B	B	B	B	B	B	B
	I	B	B	B	B	B	B	B
Occupational Health & Safety (non-Rad)	P	B	B	B	B	B	B	B
	I	B	B	B	B	B	B	B
Performance Assurance	P	B	B	B	B	B	B	B
	I	C	B	B	B	B	C	B
Quality Management	P	C	C	B	B	B	B	B
	I	C	B	B	B	B	C	B
Human Factors	P	B	B	B	B	B	B	C
	I	C	C	B	B	B	C	C
Training, Examination, and Certification	P	B	B	B	B	B	B	B
	I	C	B	B	B	B	C	B
Design & Analysis	P	B	B	B	B	B	B	B
	I	B	B	B	B	C	B	B
Safety Analysis	P	B	B	B	B	B	B	B
	I	B	B	B	B	B	B	B
Safety Issues	P	B	B	B	B	B	B	B
	I	B	B	B	B	B	B	B
Design	P	B	B	B	B	B	B	B
	I	C	B	B	B	C	B	B
Equipment Fitness for Service	P	B	B	B	B	B	B	B
	I	B	B	B	B	C	B	B
Maintenance	P	B	B	B	B	B	B	B
	I	C	B	B	B	C	B	B
Structural Integrity	P	B	B	B	B	B	B	C
	I	B	B	B	B	B	B	C
Reliability	P	B	B	B	B	B	B	B
	I	B	B	B	B	C	B	B
Equipment Qualification	P	B	B	B	B	B	B	B
	I	B	B	C	B	B	B	B
Emergency	P	A	A	A	A	A	A	A

Safety Area / Program	P or I	Bruce		Darlington	Pickering		Gentilly-2	Point Lepreau
		A	B		A	B		
Preparedness	I	A	A	A	A	A	B	B
Environmental Protection	P	B	B	B	B	B	B	B
	I	B	B	B	B	B	B	B
Radiation Protection	P	B	B	B	B	B	B	B
	I	B	B	B	B	B	B	B
Site Security	P	Secret						
	I	Secret						
Safeguards	P	B	B	B	B	B	B	B
	I	B	B	B	B	B	B	B

‘C’ grades are highlighted.

APPENDIX A

GLOSSARY OF TERMS

These terms are italicized when used in the text.

Action item
A numbered tracking system used by CNSC staff to control issues requiring licensee attention.

Calandria tubes (CT)
Tubes that span the calandria and separate the *pressure tubes* from the moderator. Each *calandria tube* contains one *pressure tube*.

Commission
A corporate body of not more than seven members, established under the Nuclear Safety and Control Act (NSCA) and appointed by the Governor in Council, to:

- regulate the development, production and use of nuclear energy and the production, possession, use and transport of nuclear substances;
- regulate the production, possession and use of prescribed equipment and prescribed information;
- implement measures respecting international control of the development, production, transport and use of nuclear energy and nuclear substances, including those respecting the non-proliferation of nuclear weapons and nuclear explosive devices; and
- disseminate scientific, technical and regulatory information concerning the activities of the CNSC and the effects on the environment and on the health and safety of persons, of the development, production, possession, transport and uses referred to above.

Commission Member Documents (CMD)
Documents prepared for *Commission* hearings and meetings by CNSC staff, proponents and intervenors. Each CMD is assigned a specific identification number.

Derived release limit
A limit imposed by the CNSC on the release of a radioactive substance from a licensed nuclear facility such that compliance with the *derived release limit* gives reasonable assurance that the regulatory dose limit is not exceeded.

Environmental qualification (EQ)
A program that establishes an integrated and comprehensive set of requirements that provide assurance that essential equipment can perform as required if exposed to harsh conditions, and that this capability is maintained over the lifespan of the plant.

Feeder
There are several hundred channels in the reactor that contain fuel. The *feeders* are pipes attached to each end of the channels used to circulate heavy water coolant from the fuel channels to the *steam generators*.

Guaranteed shutdown state (GSS)
A method for ensuring that the reactor is shut down. It includes adding a substance to the reactor moderator which absorbs neutrons and removes them from the fission chain reaction, or draining the moderator from the reactor.

International Atomic Energy Agency (IAEA)
A United Nations' agency, it establishes a system of *safeguards* to ensure that member states do not divert nuclear materials to non-peaceful activities. It also provides an international forum for nuclear safety.

Lay-up state
A special configuration into which a plant is placed to prevent system and component degradation during extended periods of shutdown.

Pressure tubes (PT)
Tubes that pass through the calandria and contain 12 or 13 fuel bundles. Pressurized heavy water flows through the tubes, cooling the fuel.

Root-cause analysis
An objective, structured, systematic and comprehensive analysis that is designed to determine the underlying reason(s) for a situation or event, and that is conducted with a level of effort that is consistent with the safety significance of the event.

Safeguards
A system of international inspection and other verification activities undertaken by staff of the *International Atomic Energy Agency* (IAEA) in order to evaluate, on an annual basis, Canada's compliance with its obligations pursuant to the *safeguards* agreements between the Government of Canada and the IAEA. In the case of Canada, the objective is for the IAEA to provide credible assurance to Canada and to the international community that all declared nuclear material is in peaceful, non-explosive uses and that there is no undeclared nuclear material or activities in this country.

Serious process failure
A failure of a process system, component or structure:
(a) that leads to a systematic fuel failure or a significant release from the nuclear power plant, or
(b) that could lead to a systematic fuel failure or a significant release in the absence of action by any *special safety system*.

Setback
A system designed to automatically reduce reactor power at a slow rate if a problem occurs. The *setback* system is part of the reactor-regulating system.

Special safety system
The shutdown system #1, the shutdown system #2, the containment system, or the emergency core cooling system, of a nuclear power plant.

Steam generator
A heat exchanger that transfers heat from the heavy water coolant to ordinary water. The ordinary water boils, producing steam to drive the turbine. The *steam generator* tubes separate the reactor coolant from the rest of the power-generating system.

Stepback
A system designed to automatically reduce reactor power at a fast rate if a problem occurs. The *stepback* system is part of the reactor-regulating system.

Systematic approach to training
A logical progression from the identification of training needs and competencies required to perform a job, to the development and implementation of training to achieve these competencies and to the subsequent evaluation of this training.

Type I inspection
An audit or evaluation carried out by CNSC staff.

Type II inspection
An equipment or system inspection or operating practice assessment carried out by CNSC staff.

APPENDIX B

ACRONYMS

These acronyms are also defined when first used in the text.

AECL	Atomic Energy of Canada Limited
ANO	Authorized Nuclear Operator
CT	calandria tube
CMD	Commission Member Document
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
CST	comprehensive simulator-based test
DRL	derived release limit
ECC	emergency core coolant
EQ	environmental qualification
GAI	generic action item
GSS	guaranteed shutdown state
HTS	heat transport system
IAEA	International Atomic Energy Agency
IST	industry standard toolset
LOCA	loss of coolant accident
LLOCA	large loss of coolant accident
NB	New Brunswick
NSCA	Nuclear Safety and Control Act
OPG	Ontario Power Generation
OSART	Operational Safety Review Team
PI	performance indicator
PRA	probabilistic risk assessment
PT	pressure tube
QA	quality assurance
SDR	Significant Development Report
SDS	shutdown system
SG	steam generator
SSC	structures, systems, and components
SLAR	spacer location and relocation

APPENDIX C

RATING SYSTEM

Grades are assigned for both design of the program, and its implementation and performance for each safety area and for programs within the safety area

A - Exceeds requirements Assessment topics or programs meet and consistently exceed applicable CNSC requirements and performance expectations. Performance is stable or improving. Any problems or issues that arise are promptly addressed, such that they do not pose an unreasonable risk to the maintenance of health, safety, security, environmental protection, or conformance with international obligations to which Canada has agreed.
B - Meets requirements Assessment topics or programs meet the intent or objectives of CNSC requirements and performance expectations. There is only minor deviation from requirements or the expectations for the design and/or execution of the programs, but these deviations do not represent an unreasonable risk to the maintenance of health, safety, security, environmental protection, or conformance with international obligations to which Canada has agreed. That is, there is some slippage with respect to the requirements and expectations for program design and execution. However those issues are considered to pose a low risk to the achievement of regulatory performance requirements and expectations of the CNSC.
C – Below requirements Performance deteriorates and falls below expectations, or assessment topics or programs deviate from the intent or objectives of CNSC requirements, to the extent that there is a moderate risk that the programs will ultimately fail to achieve expectations for the maintenance of health, safety, security, environmental protection, or conformance with international obligations to which Canada has agreed. Although the risk of programs and performance falling significantly below requirements in the short term remains low, improvements in performance or programs are required to address identified weaknesses. The licensee or applicant has taken, or is taking appropriate action.
D – Significantly below requirements Assessment topics or programs are significantly below requirements, or there is evidence of continued poor performance, to the extent that whole programs are undermined. This area is compromised. Without corrective action, there is a high probability that the deficiencies will lead to an unreasonable risk to the maintenance of health, safety, security, environmental protection, or conformance with international obligations to which Canada has agreed. Issues are not being addressed effectively by the licensee or applicant. The licensee or applicant has neither taken appropriate compensating measures nor provided an alternative plan of action.
E – Unacceptable Evidence of either an absence, total inadequacy, breakdown, or loss of control of an assessment topic or a program. There is a very high probability of an unreasonable risk to the maintenance of health, safety, security, environmental protection, or conformance with international obligations to which Canada has agreed. An appropriate regulatory response, such as an order or restrictive licensing action has been or is being implemented to rectify the situation.

APPENDIX D

SIGNIFICANT DEVELOPMENTS AND FOLLOW-UP FOR POWER REACTORS

The descriptions of significant developments are organized by site and date. Most of the information is from *Commission Member Documents* (CMD) called Significant Development Reports (SDR). For late-breaking developments that were reported orally to the *Commission*, the information is from the transcripts of the *Commission* meetings.

At the end of sub-section D.2 for Bruce B, there is an SDR on periodic inspections that also has some relevance to Bruce A.

D.1 Significant Development Reports for BRUCE A

D.1.1 Bruce A *Type II* Fire Protection Inspection

D.1.1.1 Original Description (CMD 05-M29)

Canadian Nuclear Safety *Commission* (CNSC) staff performed an unscheduled inspection at Bruce A in February. The inspection findings indicated poor housekeeping practices, unacceptably high levels of combustible loading, and the storage of combustibles in inappropriate locations. The inspection observations contravened the requirements of the National Fire Code of Canada and Canadian Standards Association (CSA) N293-95 ("Fire Protection for CANDU Nuclear Power Plants"), as referenced in the facility's operating licence.

The inspection findings led to an overall grade of "C – Below Requirements", although Units 1 and 2 received a grade of "D – Significantly Below Requirements".

Seven directives and two action notices were identified based upon the inspection. Bruce Power took action to reduce fire loading by removing items from the station. Bruce Power was expected to submit to CNSC staff within sixty (60) days a corrective action plan and schedule for addressing the inspection findings.

D.1.1.2 Initial Follow-up (Transcript to June 29, 2005 *Commission* Meeting)

Following the inspection, CNSC staff performed a follow-up inspection on June 23. The inspection revealed that the licensee was making good progress in removing combustible materials from Bruce A and that their procedures concerning the control of transient materials were being revised and improved. CNSC staff anticipated that the changes observed in the field, coupled with revisions to the operating procedures, should provide a long-term resolution to the inspection findings.

D.1.1.3 Additional Follow-up (CMD 05-M48)

CNSC staff conducted another follow-up inspection on fire protection at Bruce A on July 19. (Pictures were attached to the CMD to show the areas of concern originally identified in the February inspection and to highlight the extent to which Bruce Power has addressed the concerns).

On July 12, Bruce Power submitted an update and its response to the directives and action notices contained in CNSC staff's Fire Protection Inspection Report for Bruce A. The submission detailed Bruce Power's action plan to address the seven directives and two action notices. Bruce Power had revised some procedures which govern material storage and placement inside the station and was continuing to revise other procedures. Combustible material was being placed inside metal shipping containers to reduce the probability of fire propagation until it could be removed from the station. Some of the material stored in the station was removed and Bruce Power was planning to complete this work by January 2006. The timeline provided in the plan was acceptable to CNSC staff.

D.1.1.4 Further Follow-up

Bruce Power has submitted a corrective action plan and compliance schedule for addressing the inspection findings. The licensee has made progress in addressing the findings and CNSC staff is monitoring the licensee's implementation of corrective actions.

D.1.2 Bruce A: Unit 4 Forced Outage

D.1.2.1 Original Description (CMD 05-M40)

On May 8, Unit 4 experienced a shutdown system (SDS) #2 injection when a channel was rejected for testing and another channel's hand switch was mistakenly selected. The regulating system and SDS #1 responded as expected, causing a *setback* on neutron flux tilt, and then an SDS #1 trip on neutron log rate. The unit was resynchronized to the grid on May 11.

D.1.2.2 Follow-Up

Bruce Power followed up with an extensive self assessment related to human factors. CNSC staff also conducted a *type I inspection* on procedural compliance.

D.1.3 Bruce A Unit 3 Loss of Regulation

D.1.3.1 Original Description (Transcript to September 14, 2005 *Commission* Meeting)

On September 7, a component malfunction caused a loss of regulation at Bruce A Unit 3 that was terminated by both SDSs. The event was reported promptly by the licensee to CNSC staff pursuant to regulatory standard S-99. No radioactivity was released and there was no harm to workers or to the public. However, CNSC staff considered the event to be equivalent to a *serious process failure*, which has potential risk implications. As a result, CNSC staff oversaw Bruce Power's investigation of the event, and was satisfied that the direct cause was well-understood and that the corrective actions that were taken were adequate to correct the situation and to improve mitigation should a similar event occur in the future. Bruce Power also took similar actions on the other operating Bruce A unit (Unit 4). Unit 3 remained in a *guaranteed shutdown state* (GSS) while discussions continued regarding some residual concerns. Bruce Power formed a team to perform a *root-cause analysis*. CNSC staff informed other licensees of this event and they are examining the implications for their reactors.

D.1.3.2 Additional Information (CMD 05-M75)

Bruce Power recently completed its investigation and would shortly submit its report to CNSC staff. CNSC staff anticipated performing a thorough review in order to determine whether the proposed mitigating actions were appropriate to prevent a recurrence of this kind of event.

D.1.3.3 Follow-up (CMD 06-M4)

On December 13, Bruce Power submitted a summary of the *root-cause analysis*, which CNSC staff felt was not adequately informative. On January 16, 2006, Bruce Power provided further information on the direct cause, root cause and contributing causes. The root cause was found to be a design problem that had been allowed to persist, resulting in licensee staff not operating the system in compliance with its operating manual. CNSC staff accepted this *root-cause analysis*.

However, CNSC staff was not yet fully convinced that the circumstances of the event were fully understood. CNSC staff requested that Bruce Power perform further analysis.

D.1.3.4 Additional Follow-up (CMD 06-M4.B)

Bruce Power submitted an additional report on January 16, 2006, that analysed the design, procedural, human factors, and cultural issues that led to the event and described the direct cause, root cause, and contributing causes. CNSC staff independently verified the facts of the event and also assessed the adequacy of the *root-cause analysis*. CNSC staff was satisfied that Bruce Power correctly identified the direct cause and root cause and took appropriate corrective action.

The direct cause was the failure of the control loop to a pressure indicator, causing a helium supply valve to fail in the open position. This increased gas flow to a balance header, resulting in a rapid drop in liquid zone levels, which caused reactor power to increase. CNSC staff believes that the likelihood of a repeat event is low since the direct cause has been corrected.

The root cause was a known design problem that was not corrected but allowed to persist. The helium bleed flow to a recombiner circuit was lower than necessary, requiring gas purges in order to control the hydrogen concentration. Operations staff overcame this by setting a bleed valve controller to manual instead of automatic, in contravention of the operating instructions. When the direct cause occurred, the bleed valve was unable to react as designed, resulting in the loss of regulation.

Bruce Power corrected the design problem in Unit 3 and planned to install the change in Unit 4 during the spring 2006 outage. The design change was already installed in the Bruce B units. Bruce Power also reviewed all similar controllers and verified that they are operating in the automatic mode.

CNSC staff has closely monitored Bruce Power's investigation of the event. Immediately following the event, CNSC staff mobilized a focused inspection team, which verified that the sequence of the event was well understood. The team concluded that the immediate corrective actions undertaken by Bruce Power to reduce the likelihood of recurrence were acceptable. This was confirmed on October 12 when a similar control loop failure occurred without causing a transient.

The event was significant in that it was a slow loss of regulation, which was eventually terminated by SDS action. As to whether or not the event was a *serious process failure* as defined in regulatory standard S-99, Bruce Power contends that it is not. Before CNSC staff can reach a position on this, it awaits a detailed confirmatory analysis which has been committed for completion in May 2006. CNSC staff will continue to monitor the completion of this and other corrective actions in order to determine whether additional risk mitigation actions are necessary.

CNSC staff concludes that the event posed no risk to public health and safety. CNSC staff is satisfied that Bruce Power correctly identified the direct cause and root cause and took appropriate corrective action.

D.2 Significant Development Reports for BRUCE B

D.2.1 Bruce B Unit 7 Unplanned Reactor Shutdown (CMD 05-M10A)

On February 9, Bruce B Unit 7 experienced an SDS #2 trip. At the time, one channel was rejected for maintenance and a spurious signal on one of the two remaining channels caused an injection of SDS #2. The reactor was resynchronized to the grid on February 13.

D.2.2 Bruce B Unit 6 Transformer

D.2.2.1 Original Description (CMD 05-M29)

On April 15, Unit 6 was safely shut down following an electrical fault and fire on the main output transformer. This event occurred on the non-nuclear side of the station. The fire was extinguished by an automatic fire suppression system as per design. There were no injuries.

As a result of this event, there was a spill of biodegradable mineral oil into Lake Huron through surface drains. This oil contained no polychlorinated biphenyls (PCB) or radioactive material. Bruce Power was in the process of cleaning up the spill; the majority of the oil released from the damaged transformer had either been recovered or absorbed by the sand and gravel beneath the transformer. The Ontario Ministry of Environment was overseeing the clean-up activities. Hydro One maintenance crews were called in to replace the transformer with a spare phase.

D.2.2.2 Follow-up

As this was a conventional spill, follow-up was conducted by the Ontario Ministry of the Environment. Crews replaced the transformer with the spare and Unit 6 returned to service on May 14.

D.2.3 Bruce B Unit 6 Partially Opened Vent Valve (CMD 05-M75A)

On November 18, a Bruce Power employee was in containment to repair a failed maintenance cooling system valve. The employee either bumped a vent valve or his air hose got tangled with its handle, resulting in the vent valve partially opening. The partially opened vent valve resulted in the heavy water of the heat transport system (HTS) draining into the collection system. The collection system capacity was exceeded causing the heavy water to overflow into the HTS feed pump room and HTS collection room.

Bruce Power initiated a unit alert. The emergency control room personnel responded and followed appropriate procedures, including activation of the Emergency Operations Centre and initiation of accounting of station personnel. Bruce Power staff controlled the contamination, cleaned up the leaked heavy water, and performed analyses to confirm the design conditions for the components were not exceeded.

Unit 6 was returned to power. There were no injuries, over-exposures, or releases to the environment as a result of the event.

D.2.4 Bruce B: CSA N285.5 Periodic Inspections

D.2.4.1 Original Description (CMD 05-M40)

Bruce Power had not yet submitted its periodic inspection programs for Bruce B as required by standards CSA N285.4-94 and N285.5-M90. In addition, approximately 10% of the Bruce B containment structure inspections required by CSA N285.5 were not completed within the required time.

CSA-N285.5-M90 requires that certain containment structure components be inspected on a ten-year cycle. The cycle was originally due to end in spring 2002, but the requirement was extended to autumn 2004 when deferral of the vacuum building outage was allowed. In March 2005, Bruce Power informed CNSC staff that the inspection program had not been completed. A work plan to rectify the shortcoming and propose a submission date for the program was expected prior to the end of June.

The periodic inspection programs for Bruce A were submitted as required prior to the restart of Units 3 and 4. However, Bruce Power reported missing a few of those inspections also.

D.2.4.2 Additional Information (Transcript from June 29, 2005 *Commission* Meeting)

In June 2005, Bruce Power submitted its review of the performance of its periodic inspection program against the requirements and a plan and schedule to address the deficiencies and outstanding issues. Bruce Power was expected to submit their periodic inspection program for approval soon thereafter. CNSC staff anticipated conducting a *type I inspection* of both the program and its implementation.

D.2.4.3 Follow-up

The CSA N285.5-M90 program for Bruce B remains current, as required by its license condition. The CSA N285.4-94 programs for Bruce B should be submitted by June 2006. Some reports related to CSA N285.4 were submitted up to three years late.

The CSA N285.4 and N285.5-M90 periodic inspection programs for Bruce A were submitted as required prior to the restart of Units 3 and 4. However, Bruce Power recently reported missing a few of the inspections. CNSC staff is currently investigating.

Bruce Power management is currently making steady progress to get the four programs back on track.

D.3 Significant Development Reports for DARLINGTON

There were no SDRs for Darlington in 2005.

D.4 Significant Development Reports for PICKERING A

D.4.1 Unavailability of Emergency Core Coolant Injection at Unit 4 (CMD 05-M4)

While performing routine checks, Ontario Power Generation (OPG) discovered that a seismically-qualified circuit breaker was in the open position. This resulted in an emergency core coolant (ECC) injection system valve being unable to operate, making that *special safety system* unavailable for a few hours. The initial assessment indicated that a switch on the breaker was bumped inadvertently, causing it to open the breaker. A protective barrier was installed around the switch. CNSC staff judged that OPG took adequate corrective actions to prevent a repeat of this failure.

D.4.2 *Environmental Qualification* at Unit 4 (CMD 05-M4)

Following a review of Darlington's operating experience with steam barriers, OPG completed a thorough assessment of the "H-line wall" around Units 3 and 4 and found some impairment of the Pickering A steam barrier. The stairwells on Units 3 and 4 were found to require reinforcement and the repairs were completed.

D.4.3 Loss of Class IV Power at Unit 4 (CMD 05-M4)

On December 9, Unit 4 was at 87% and returning to full power following the completion of an outage. Class IV power was lost and resulted in a reactor trip. The unit was safely shut down, and Class IV power was restored in approximately 22 minutes and the unit was placed in GSS.

The cause of the loss of Class IV power was determined to be a line fault on one of the transmission lines between Unit 4 and a Hydro One transformer station at a time when the other line was removed from service to test the new remote generators. An intermittent phase-to-ground fault within the excitation unit caused a noticeable flashover and smoke. There was no fire; however, the local fire department responded to the alarm. CNSC staff was satisfied with the response of the unit and OPG's staff during the incident.

D.4.4 Pickering A Unit 4 *Feeder* Elbow Wall Thickness

D.4.4.1 Original Description (CMD 05-M18B)

OPG obtained the results of the metallurgical examination of two *feeders* that were removed from Pickering A Unit 1 following an assessment of their fitness for service. The fitness for service analysis was based on field measurements of wall thicknesses at the extrados of the elbows. Four *feeders* were removed and the two that had wall thicknesses closest to the code allowable limit were selected for metallurgical examination. The examination found locations near the *feeder* elbow intrados with wall thicknesses less than those found on the extrados. In one case the thickness was found to be below the code allowable limit.

Feeder thinning at the elbow intrados had not been anticipated or checked during the periodic fitness for service inspections of any of the units at Pickering A. On April 2, OPG decided to shut down Unit 4 because of the uncertainty of the fitness for service of the *feeders*. OPG planned to inspect the intrados of the *feeder* elbows at both Unit 4 and Unit 1 before restart.

D.4.4.2 Follow-up

The *feeders* removed from Unit 1 were also observed to have deep localized thinning adjacent to welds. In response to this new finding, the licensees developed a new tool to reliably measure wall thickness close to the weld. The CANDU Owners' Group has been developing new fitness-for-service guidelines (expected to be issued in 2006) for highly localized wall thinning near welds.

OPG expanded the inspection scope of Unit 1 *feeders* and subsequently removed a *feeder* due to wall thinning near the Grayloc hub weld.

OPG inspected wall thinning in 142 outlet *feeders* and 11 inlet *feeders* in Unit 4. OPG replaced two outlet *feeders* that were assessed to reach a life-limiting wall thickness prior to the next planned inspection. One other outlet *feeder* was assessed to have insufficient remaining thickness until the next outage. However, OPG's detailed analysis demonstrated that it would be fit for service over the next operating cycle.

CNSC staff judged that the results of the *feeder* inspections at Pickering A were acceptable and supported the continued safe operation of Units 1 and 4, which were subsequently restarted in 2005.

D.4.5 Suspicious Item at Pickering A Unit 1

D.4.5.1 Original Description (CMD 05-M40)

On June 3, a plant worker noticed a suspicious item in Pickering A and notified OPG security. In accordance with procedures, a station emergency was declared and assistance was requested from the Durham Regional Police. OPG's Pickering Site Management Centre assembled to direct the response to the event, and a member of CNSC's site staff was present at the Site Management Centre throughout the incident. In Ottawa, CNSC staff set up the on-site liaison room in the Emergency Operations Centre to monitor the situation. Within a few hours, the item was determined to be harmless and the station emergency was terminated. A criminal investigation was in progress to determine who assembled the device.

On June 8, another employee noticed a suspicious item in the Unit 1 reactor building and notified security. A station emergency was declared and was terminated soon thereafter when Durham Regional Police determined that the item was harmless and, unlike the previous incident, not purposely assembled or placed.

D.4.5.2 Follow-up

The investigation of the incident on June 3 by Durham Regional Police did not result in any positive identification of suspects.

D.4.6 Decision Not to Restart Pickering Units 2 and 3 (Transcript to August 17, 2005 *Commission* Meeting)

OPG announced that it would not proceed with the restart of Units 2 and 3 at Pickering, but to put them in a de-fuelled, permanent shutdown state.

D.4.7 Electrical Transient at Pickering A Unit 4

D.4.7.1 Original Description (CMD 05-M53)

On August 19, a severe thunder storm caused an electrical transient which, together with an equipment failure, caused a loss of Class III power to ECC valves, resulting in ECC unavailability for about one hour. While the event had no direct consequences, there would have been no means (see section D.4.7.2 for clarification) to make up lost coolant from the HTS in the event of a pipe break while ECC was unavailable. While the time at risk was minimal, there was a significant reduction in defence-in-depth during this event.

D.4.7.2 Additional Information (Transcript to September 14, 2005 *Commission* Meeting)

The lightning strike resulted in a loss of power to one half of the injection valves. Therefore, the statement that there were no means to make up for lost coolant was not true. While ECC was considered unavailable, half of the flow was still available.

D.4.8 Unavailability of Emergency Core Coolant at Pickering A Unit 4

D.4.8.1 Original Description (CMD 05-M59)

On September 22 during a routine test, there was a temporary loss of power to one half of the ECC valves. This resulted in ECC unavailability for about one-and-a-half hours. While the event had no direct consequences, there would have been no means to open the ECC valves to four of the eight reactor headers during the power loss. In the absence of analysis, there is no assurance of adequate fuel cooling for every possible HTS pipe break location unless the ECC injection valves to all eight HTS headers can be opened.

OPG's investigation of the event uncovered that it was the result of changes to seismically-qualified relays in the power supply control system. The slower operating time of the new relays causes the failure of the back-up power supply during routine testing. This problem only recently caused the test to fail because the relays now have slower operating times than when they were originally installed (about two years ago). OPG also determined that this problem only affects the system during testing and that the transfer to backup power would operate correctly when required during a loss of coolant accident (LOCA) together with a loss of off-site power. OPG has suspended this test until the relay problem is corrected, and was also investigating the process that was used to select the new relays.

D.4.8.2 Follow-up

OPG is preparing an additional document to report on a review of similar events, *root-cause analysis*, and required follow-up actions.

D.4.9 Long-Term Safe Storage at Pickering A Units 2 and 3 (CMD 05-M75A)

OPG informed CNSC staff of the decision not to return Pickering Units 2 and 3 to service. Instead, Units 2 and 3 would be placed in long-term safe storage. OPG's intent was to remove the fuel and heavy water from the reactors. All activities required to place the units in the safe storage state would be performed under the existing operating licence.

D.4.10 Follow-up to Pickering A Operational Safety Review Team (CMD 06-M4.B)

In CMD 04-M29, CNSC staff reported on the results of the review by the Operational Safety Review Team (OSART) that was conducted by the *International Atomic Energy Agency* (IAEA) at Pickering A in February 2004. Following standard practice, CNSC staff invited the IAEA to return to Pickering A in September to assess OPG's progress in addressing the OSART's recommendations and suggestions. The purpose of the follow-up visit was to determine the status of all proposals for improvement, to comment on the appropriateness of the actions taken, and to assess the degree of progress achieved.

The OSART follow-up review team categorized the status of all the plant corrective actions and provided comments on them, including some additional suggestions for improvement. It found that, of the 23 issues, including 12 recommendations and 11 suggestions identified by the OSART mission in February 2004, 10 were considered resolved and 13 were found to have made satisfactory progress toward completion. The team identified adherence to steam door and fire door requirements as an area for improvement that still exists, but also noted visible improvements in plant housekeeping and foreign material exclusion practices.

The overall conclusion of the review was that the plant made significant progress in correcting all issues identified during the 2004 OSART mission. Strategic plans were developed; responsibilities assigned; corrective actions were being addressed; modifications were planned, and results were trended and communicated. The team also noted good management and staff engagement in the many long-term initiatives to ensure the sustainability of the results.

D.5 Significant Development Reports for PICKERING B

D.5.1 Pickering B Follow-up on Service Water Issues

D.5.1.1 Original Description (CMD 05-M18)

There were three remaining issues from CNSC staff's investigation on the loss of bulk electricity system event in August 2003 (see 2004 industry report, CMD 05-M31 for details). These three issues were related to service water supply capacity, service water surveillance and maintenance, and fire water supply capacity.

Since November 2004, OPG improved the service water system capacity by refurbishing all emergency high- and low-pressure service water pumps on Unit 7. The same pumps on Unit 5 were being overhauled and the remaining overhauls were scheduled for planned outages.

OPG completed and submitted the operational safety requirements document for the service water systems. This document showed that the service water systems are able to meet all their capability requirements. Work was still underway to completely resolve the fire water capacity issue.

OPG submitted action plans, with identified activities and schedules relating to service water design, operation, surveillance, maintenance, and safety analysis to completely resolve the three remaining issues.

CNSC staff was reviewing the submissions to confirm if the submitted action plans would address and resolve all the identified issues.

D.5.1.2 Follow-up

Additional information relating to service water was provided by OPG and is being reviewed by CNSC staff.

D.5.2 Unavailability of Standby Generators at Pickering B Units 7 and 8

D.5.2.1 Original Description (CMD 05-M46)

OPG determined that, due to independent failures of two of the three standby generators which supply Units 7 and 8, all three standby generators were unavailable for a period of five-and-a-half days in June. While standby generator #1 was undergoing planned maintenance, both standby generator #2 and #3 were found to be unavailable during testing. The failure of standby generator #2 was due to a mis-positioned valve and the failure of standby generator #3 was caused by a defective timer. Both standby generator #2 and #3 were subsequently repaired, tested and returned to service.

The Pickering B standby Class III power system is supplied by six gas turbine driven generators arranged in two banks of three, with one bank supplying Units 5 and 6 and the other supplying Units 7 and 8. The minimum requirement is to have at least one of the three standby generators available to supply each pair of units. Thus, during the time when all three standby generators were unavailable to supply Units 7 and 8, the system did not meet its design intent. Class III power supplies other safety related systems which, in the event of a loss of off-site power if no units remain on-line, are required for safe reactor shutdown and long-term heat removal, as well as emergency cooling in the case of LOCA.

Although OPG's monitoring of the system indicated it was in need of improvement, this was the first time it was found to be unavailable. CNSC staff was reviewing the results of OPG's investigation of this event, as well as the improvements that were planned to increase the standby generator reliability.

D.5.2.2 Initial Follow-up (CMD 05-M75.A)

CNSC staff performed a risk significance assessment of Class III power unavailability and concluded that an important layer of defence was lost during the event. As a result of this assessment, CNSC staff planned to conduct an inspection of the emergency power and emergency water systems, which are required to mitigate a loss of Class IV and Class III power.

CNSC staff judged that adequate mitigating actions were taken by OPG immediately following the event to correct the three problems that led to the incident. The mitigating actions were:

- changes were made to routine testing prior to, and during, a long maintenance outage of a standby generator;
- the valves that had been inadvertently opened were later secured in a closed position on all of the standby generators; and
- the timer relays were replaced.

CNSC staff reviewed the preliminary information and met with OPG staff to discuss the causes of this event. CNSC staff closely monitored the completion of all corrective actions planned by OPG, including:

- timely completion of planned standby generator upgrades;
- better prioritization of maintenance work; and
- timely procurement of parts with the correct quality level for safety-related equipment.

CNSC staff planned to perform an inspection of plant equipment condition at Pickering B in December to investigate the quality level issue for safety-related equipment.

D.5.2.3 Additional Follow-up

CNSC staff performed an electrical systems inspection at Pickering B in March 2006.

D.5.3 Pickering B Unit 8 Trip and Partial Loss of Class IV Power

D.5.3.1 Original Description (Transcript to August 17, 2005 *Commission* Meeting)

On August 6, Unit 8 tripped as a result of a technician performing work on the wrong instrumentation channel of SDS #2. During the subsequent restart of the unit, failures in the electrical systems resulted in a partial loss of Class IV (off-site) power and a further reactor trip. OPG replaced a component, returned the unit to service, and initiated an investigation into the cause of the electrical failure.

D.5.3.2 Follow-up

OPG has determined that a failed relay caused this event and the need for a design change is being assessed.

D.5.4 Shutdown of Pickering B Units 5, 6 and 8

D.5.4.1 Original Description (CMD 05-M53)

On August 19, Pickering B shut down three of the four operating units due to wind conditions that resulted in a large influx of algae to the screen house. Fouling of the screens temporarily reduced the intake flow of cooling water for the turbine condensers, causing the turbines to trip. Although a multi-unit transient and shutdown of multiple units places a very high workload on operational staff, Units 5, 6, and 8 were safely placed in a forced outage with no major problems. By August 22, all of the units were returned to full power.

The subsequent review of the event determined that the three units were shut down before a standby generator and a high-pressure ECC pump were started. As a result, during about two hours, no power would have been available to the high-pressure ECC pumps that were necessary to ensure fuel cooling in the event of a LOCA and loss of off-site power to the remaining operating reactor (Unit 7). Although there was a loss of defence-in-depth, a simultaneous LOCA and loss of off-site power is very unlikely. However, following the shutdown of three Pickering units, the probability of a loss of off-site power was higher than normal. In addition to the potential ECC unavailability, OPG was reviewing some equipment issues and possible improvements to procedural guidance for mitigating this type of event.

D.5.4.2 Follow-up

OPG has undertaken a number of improvements to optimize the station response to this type of event.

D.5.5 Heavy Water Leakage Outside Pickering B Unit 5

D.5.5.1 Original Description (CMD 06-M4.B)

On December 3, while conducting a routine test of ECC valves, OPG discovered that heavy water had leaked from the test pressurizing line onto the pavement outside the Unit 5 reactor building. OPG estimated the size of the spill to be 460 kg. While much of the water was frozen, a small amount was unrecoverable, having evaporated (~60 kg) or discharged through drainage into the lake (~100 kg). CNSC staff was satisfied with the mitigating actions taken by OPG in response to the leak, as well as OPG's environmental sampling and surveys, which showed that the resulting emissions to the environment were well within regulatory limits.

The rupture occurred as result of the formation of ice in the piping. The pipe freezing should have been prevented by a trace heating system that was out of service for maintenance. While the sole cause of the failure was the over-pressurization due to the ice formation, during repair of the line, some pipe wall thinning due to surface corrosion was detected. This was attributed to continual wetting of the carbon steel piping due to introduction and retention of moisture by the insulation material surrounding the pipe. OPG repaired the piping and installed a new type of insulation that does not retain moisture and should limit corrosion if the pipe cladding fails to prevent moisture from reaching the insulation. CNSC staff was satisfied with the additional inspections and corrective actions planned and performed by OPG to ensure adequate wall thickness, insulation, and cladding in other piping that might be susceptible to the same type of degradation.

OPG completed an assessment of the safety significance for the ECC system during the time between the occurrence of the pipe rupture and the isolation of the leak, estimated to be about 42 hours. Although fuel cooling in the event of a LOCA would not have been compromised, the pipe failure would have had an impact on ECC availability because of the containment function during ECC recovery. This is because ECC system recovery piping is outside of containment and is required to provide a containment function following the transition to the recovery phase. CNSC staff is reviewing OPG's assessment of the risk impact of the pipe failure, which was found to be very small. The risk was found to be very small both because of the low probability of occurrence of a large LOCA and because fuel cooling during a LOCA would not have been compromised by the failure.

D.5.5.2 Follow-up

OPG made improvements to ensure the availability of heat tracing to prevent recurrence of this type of event.

D.6 Significant Development Reports for GENTILLY-2

D.6.1 Unplanned Shutdown of Gentilly-2 (CMD 05-M4)

In the light of the new technical calculations for *pressure tubes* (PT), Hydro-Québec took the precaution of shutting down Gentilly-2 on December 4, 2004. According to Hydro-Québec, a revised modelling of the PT creep had predicted a significant probability (approximately 30 %) that one of the 380 PTs inside the reactor was in contact with a *calandria tube* (CT).

On inspection, no blisters were found on the PT in question or the other three tubes identified as suspect. Hydro-Québec discussed the results with CNSC staff and began start-up of the reactor on December 16, 2004. Gentilly-2 reached full power two days later.

D.6.1.1 Follow-up

Following discussions with Hydro-Québec, CNSC staff determined that all issues had been resolved and the corresponding *action item* was closed on June 9.

D.6.2 Cleaning of *Steam Generators*

D.6.2.1 Original Description (CMD 05-M29)

Four incidents related to the cleaning of the *steam generators* occurred during the scheduled maintenance shutdown at Gentilly-2, which started on April 15.

- Chemical contamination (ammonia, morpholine, hydrazine) of the service sink and the feedwater tank occurred from April 16 to 17.
- Two employees were bothered by ammonia fumes on April 21 in one of the rooms of the service building and were taken to hospital.
- On April 21, a hose installed for cleaning purposes ruptured, causing approximately 5 centimetres of contaminated water to spill and accumulate on the basement floor of the turbine building.
- A release of ammonia occurred on April 26 near the main steam collector in the turbine building when a valve was opened.

The contaminated water also contained a copper concentration in excess of the acceptable limits set by the Québec department of the environment for the release of water into the St. Lawrence River. Therefore, the contaminated water was kept in the service sink until an acceptable way could be found to dispose of it. Hydro-Québec was discussing the matter with the department of the environment on a regular basis.

As a precaution, the two employees involved in the second incident were taken to hospital. The Québec Workmen's Compensation Board was not notified because there were no injuries and no loss of work time. A medical examination of the employees at the hospital determined that their health had not been affected.

Regarding the third incident, the contaminated water was recovered from the floor. Hydro-Québec also evacuated the turbine building and collected air samples to confirm that the concentration of chemicals in the air was within acceptable limits before allowing people back into the building.

Regarding the fourth incident, Hydro-Québec suspended all new work on the secondary side following the release. A special group was formed to identify and correct the causes of such incidents.

In addition to its immediate response activities and the filing of a preliminary report with the CNSC, Hydro-Québec launched an investigation to identify the underlying causes. CNSC staff continued to monitor the scope and thoroughness of the investigation through discussions with Hydro-Québec staff, review of relevant documents, and field visits.

D.6.2.2 Follow-up

Discussions on the disposal of contaminated water are ongoing. CNSC staff visited the site to monitor the licensee's investigation and awaits the formal report on the *root-cause analysis* of these events.

D.7 Significant Development Reports for POINT LEPREAU

D.7.1 Point Lepreau Forced Outage (CMD 05-M18B)

On March 30, standby generator #2 had a running failure while operating in support of a maintenance overhaul of standby generator #1. This resulted in the unavailability of both standby generators and, hence, a reduction in the defence-in-depth of the Class III power.

The nature of the malfunction of standby generator #2 could not be determined and repaired within the limit of eight hours prescribed by the station's operating policies and principles. New Brunswick (NB) Power Nuclear complied with its operating licence condition and initiated an orderly station shutdown on March 31.

The problem with standby generator #2 was subsequently diagnosed during the following shift and a faulty mechanical governor unit was replaced. Standby generator #2 was tested and declared available for service on April 1. The station was then returned to service.

D.7.2 Point Lepreau Planned Maintenance Outage

D.7.2.1 Original Description (CMD 05-M29)

The station was shut down for its annual planned maintenance outage on April 15. *Feeder* inspections revealed crack indications in seven *feeder* bends. All crack indications were on 2.5 inch diameter outlet *feeders* with tight radius (>45 degree) bends. NB Power Nuclear planned to repair those *feeders* during the outage.

CNSC staff has been monitoring this issue since the first crack indications were discovered on April 17, 2005, and is awaiting details on NB Power Nuclear's evaluation of the inspection results and future plans.

D.7.2.2 Follow-up

All *feeders* with crack indications were replaced during the outage. NB Power Nuclear forwarded its evaluation of the 2005 *feeder* inspection results and future life cycle management plans to the CNSC. CNSC staff was satisfied with the evaluation of the results and the plans, which will include additional inspections. It is worth noting that a pressure test conducted later on a removed *feeder* showed ample margin above its design requirements. Also, during a more in-depth examination of the *feeders* that were removed from the reactor, several apparently positive indications of cracking were later confirmed to be false.

A post-removal inspection discovered that one of the cracks was initiated on the outside surface of the pipe while all other cracks were initiated on the inside surface. It was also revealed that some of the *feeders* experienced reductions in wall thickness that could limit the life of the *feeder*. NB Power Nuclear evaluated the fitness-for-service of the *feeders* from the perspective of wall thinning. In view of the uncertainties related to the stability of cracks on the outer surface of the thinnest *feeders,* the licensee also replaced the six outlet *feeders* that were predicted to potentially exceed 40% wall thickness loss prior to the 2006 outage. (In January 2005, Point Lepreau had added supplementary activities to the *feeder* life cycle management plan to address emerging information on the presence of outside surface cracks and concerns over outlet *feeders* that have thinned below the CSA disposition level with the possibility of outside surface cracks at the extrados of tight radius bends.)

D.7.3 Decision to Refurbish Point Lepreau (Transcript to August 17, 2005 *Commission* Meeting)

On July 29, New Brunswick Premier Bernard Lord announced provincial approval for NB Power Nuclear to proceed with refurbishment of the Point Lepreau station. NB Power Nuclear indicated that work on the detailed engineering and planning would begin in the summer. Some substantial preparatory work was already completed and planned maintenance is scheduled to begin in 2008. CNSC staff is reviewing the project and formulating plans for regulatory oversight.

APPENDIX E

GENERIC ACTION ITEMS

Safety Issues relate to the identification and resolution of issues arising from research, incorporation of new knowledge, hazard analysis or accident mitigation strategies. A safety-related concern that cannot be resolved based on the currently available knowledge is referred to as an outstanding safety issue. Canadian Nuclear Safety *Commission* (CNSC) staff has formally documented those outstanding safety issues that are common to more than one station and complex in nature as “Generic Action Items” (GAI). Further work, occasionally including experimental research, is required to more accurately determine the overall effect of a GAI on the safety of the facility. To ensure that CNSC expectations are clear for each GAI, CNSC staff has developed position statements that include closure criteria and an expected timeframe for closure.

Nevertheless, CNSC staff judges that continued station operation is permissible, because the majority of GAIs deal with situations where safety margins still exist but may be subject to potential degradation. Issues with confirmed, immediate safety significance are addressed by other means on a priority basis.

The following describes the progress for each GAI in 2005.

GAI 88G02 - Hydrogen Behaviour in CANDU Nuclear Generating Stations

Loss of coolant accidents (LOCA) can lead to substantial hydrogen releases to containment. Radiolysis of the water in the primary heat transport system by radiation fields from intact fuel in the core is recognized as the primary source for hydrogen generation. Radiolysis of the water collected in the containment by radio-nuclides released from failed fuel bundles can also lead to release of appreciable amount of hydrogen to the containment (long term). In addition, for LOCA scenarios where emergency core coolant (ECC) initiation cannot be credited, oxidation of over-heated fuel sheath is expected to result in short-term releases of hydrogen into the containment. The more significant long term hydrogen releases have been shown to induce flammable and potentially explosive gas mixtures covering entire containment compartments, while the short term releases can have similar local impact in certain regions of the affected compartments. Sensitivity studies on post-blow-down steam flows through the core have indicated an escalation in hydrogen and radionuclide releases for fuel channel flow rates below 100 g/s, with a peak around 10 to 20 g/s.

A significant safety issue, unless appropriate mitigation is provided, is the challenge posed to the integrity of the containment systems and the necessary or credited post-accident structures, systems and components (SSC) inside containment, by the large combustion and potentially explosive loads from possible ignition of the long term hydrogen releases. A second significant safety issue is related to the challenge posed to the post-accident performance of containment and its necessary/credited SSCs, by inadequate *environmental qualification* to the induced harsh radiological and potential combustion conditions. Mitigation of the long term hydrogen releases is also needed for viable severe accident management.

CNSC staff has expressed concerns as to whether the licensee's adopted course of action would be sufficient to resolve this containment issue. CNSC staff is finalizing the position with regard to the path that is to be taken to achieve an optimum level of containment protection using either the deterministic dual failure approach adopted by Hydro-Québec or the essentially probabilistic approach adopted by other utilities. Factors requiring additional consideration include the need to: (1) adopt a separate approach for refurbished units and for units approaching their end of life, (2) address severe accidents in a consistent manner, and (3) ensure consistency with proposed modifications to the licensing basis of existing reactors.

Since CNSC staff has decided to revise their approach to the closure of this GAI, licensee performance has not been ranked this year.

GAI 91G01 - Post-Accident Filter Effectiveness

In certain postulated accidents, venting of containment may be needed to reduce the risk of an uncontrolled release of radioactive material. The licensees have been required to demonstrate that the filters are capable of performing their design function and that adequate testing and maintenance activities for them are in place. The filters covered by this GAI are containment emergency filtered air discharge system filters and other filters that are credited in safety analyses.

The GAI is closed for the Hydro-Québec (Gentilly-2), Ontario Power Generation (Pickering A and B and Darlington), and Bruce Power (Bruce A and B) plants. CNSC staff is waiting for New Brunswick (NB) Power Nuclear to present an argument similar to Hydro-Québec's and to provide details on how conditions in containment would be stabilized in the long term following such accidents.

GAI 94G02 - Impact of Fuel Bundle Condition on Reactor Safety

The condition of certain fuel bundles irradiated in CANDU reactors has been observed to differ from that predicted and accounted for in design, operation, and safety analysis documentation. The fuel bundles in question have shown signs of more-than-expected degradation such as end plate cracking, spacer pad wear, element bowing, sheath wear, bearing pad wear, sheath strain, disappearance of the CANLUB layer, oxidation of defective fuel and fission product release.

Fuel bundle degradation depends on the reactor, fuel channel and fuel designs, fuel manufacture and operating conditions. Since theoretical models have been unable to correlate these factors adequately to the fuel condition, fuel and *pressure tube* (PT) inspections are necessary. Owing to the number of factors upon which the degradation depends, the inspection program must be extended beyond inspection of defective fuel to observe these changes. In addition, fuel bundle degradation is sometimes also accompanied by fretting and scratching of the PT and may depend on other phenomena such as PT creep.

The effects of bundle degradation on reactor safety are not fully known, partially because of limited experimental data and safety analysis methods. Also, it is important to monitor fuel performance by conducting fuel inspections and examinations, and integrated evaluation of relevant information. As such, the important fuel and fuel channel parameter to measure are not known. Although some fuel inspections have been conducted and the results have been submitted to the CNSC, licensees do not have a formal process to ensure that the fuel and fuel channel conditions are identified and accounted for.

Consequently, the licensees have been required to:

- implement an action plan to eliminate excess fuel and fuel channel degradation in acoustically active channels; and
- implement an effective, formal, and systematic process for integrating fuel design, fuel and channel inspection (in-situ), fuel and fuel channel laboratory examination, research, operating limits and safety analysis.

This GAI was closed for Ontario Power Generation (OPG) and Bruce Power in 2001 and 2002 respectively. Hydro-Québec and NB Power Nuclear have submitted information describing the station processes and requested closure of this GAI. Closing of this GAI for these licensees is pending their response to questions raised by CNSC staff.

GAI 95G01 - Molten Fuel-Moderator Interaction

A severe flow blockage in a fuel channel, or an inlet *feeder* stagnation break, could potentially lead to fuel melting, channel rupture and ejection of molten fuel into the moderator. It is uncertain as to whether the resulting molten fuel/moderator interaction could damage the shut-off rod guide tubes and prevent shutdown system (SDS) #1 from functioning properly. It could also damage other fuel channels, or the calandria vessel itself.

There has been a long-standing difference of opinion between CNSC staff and licensees and their respective consultants on the severity of the molten fuel/moderator interaction. Starting the first quarter of 2000, however, licensees initiated an experimental program to resolve this matter. A panel of three independent fuel-coolant interaction experts was set up to review the experimental program and the resolution criteria proposed by industry. CNSC staff accepted the panel's final recommendations and the industry's proposed closure criteria.

CNSC staff has also accepted the licensees' proposed experimental program schedule, which planned to conclude the experimental program by the third quarter of 2005. Although some delays have been encountered due to unexpected technical challenges and problems in obtaining the code classification approval for the test facility, the first of the planned four tests has been carried out successfully in December 2004. Experience from this test indicates that the time required to perform post test analysis is longer than expected, and the schedule for closing this GAI has been revised to June 2008. In December 2005, a second test was carried out.

GAI 95G02 - *Pressure Tube* Failure with Consequential Loss of Moderator

Traditionally, the single and dual failure concept in safety analyses calls for analyses of initiating events, plus analyses of initiating events coupled with failure of one of the *special safety systems*. For the postulated scenario of LOCA plus loss of emergency core coolant (ECC), the moderator system has been credited in the analysis as a heat sink. Heat transfer to the moderator is assumed to be via PT contact with *calandria tubes* (CT) following PT deformation due to heat-up. This mode of heat transfer has been accepted by CNSC staff, since the moderator was considered to be independent of postulated initiating events and ECC failures. However, experiments suggest that it is possible for the moderator water to drain during the following postulated scenario: rupture of the PT and then end-fitting bellows, followed by CT failure, guillotine failure of the already ruptured PT, end fitting ejection and drainage of the moderator. This postulated event could result in severe damage to a large number of channels, with consequences in excess of those anticipated in the safety report.

In a position statement addressing this GAI, licensees were requested to provide acceptable proposals for a course of action, including possible design changes to be implemented by the end of 2000 that would result in the mitigation of, or at least a significant reduction in, the impact of the consequences of such an event.

An industry plan of action was submitted to CNSC staff in May 2000. In this plan, the industry presented its proposed evaluation criteria, including a proposed cost-benefit methodology. Subsequently, CNSC staff has modified its position statement to refer to the CNSC policy on the use of cost-benefit arguments, and to modify the closure criteria and the completion schedule to reflect recent CNSC staff and industry discussions.

The industry has submitted the basis for their plans of actions in accordance with the revised position statement for this GAI, and requested closure. CNSC staff has carried out the review of the measures proposed by the licensees to reduce the potential risk associated with this postulated event.

NB Power Nuclear considered the replacement of existing seam-welded CT by the seamless CT as part of its refurbishment plan. NB Power Nuclear submitted the documents describing the CT qualification program and component verification specification in February 2004. In September 2005, however, NB Power Nuclear informed CNSC staff that it was not possible to qualify the seamless CT in time for the refurbishment of the plant. Presently NB Power Nuclear is evaluating other options to resolve this GAI. CNSC staff review of this issue is therefore on-going.

GAI 95G04 - Positive Void Reactivity Uncertainty – Treatment in Large LOCA Analysis

Accuracy of void reactivity calculations is a significant safety issue in the analyses of design basis accidents involving channel voiding, especially for large LOCAs (LLOCA). In 1995, CNSC staff raised concerns about the adequacy of available evidence in support of best-estimate predictions of void reactivity, and subsequently requested all licensees to complete a suitable experimental program to improve related safety analyses, and to undertake adequate interim measures.

In 2001, a CANDU Owner's Group report on void reactivity error assessment for CANDU reactors was issued. It summarized the results arising from the overall industry program to address GAI 95G04. It was concluded that the new industry standard toolset (IST) reactor physics suite of computer codes over-predicts the void reactivity of CANDU fuel when compared to the ZED-2 research reactor measurements. The report recommended fuel-type specific values for the errors to be applied in void reactivity calculations by IST reactor physics codes for operating CANDU conditions at all fuel burn-ups. This recommended value of over prediction of void reactivity has been credited in the recent LLOCA safety analyses with the new IST reactor physics suite of codes.

The acceptability of the estimate of uncertainty in the IST reactor physics codes' prediction of void reactivity for operating CANDU conditions has also been discussed in an industry-proposed independent panel assessment. The panel report was completed and issued in January 2003. The industry dispositioned the recommendations that were made and proposed relevant research and development activities. The bulk of proposed activities has been completed in 2004 and all licensees requested the closure of this GAI in December 2004. CNSC review of the submitted information is currently in progress.

GAI 95G05 - Moderator Temperature Predictions

In some LLOCA events, the integrity of fuel channels depends on the capability of the moderator to act as the ultimate heat sink. As fuel channels heat up, PTs radially balloon and come into contact with the CTs. Fuel channels remain intact upon contact if the moderator fluid outside the CT is cold enough to provide good heat removal capability. Channels may fail, however, if the moderator temperature is too high to prevent the outside of the CT from drying out following contact on the inside with the PT.

In view of the severe consequences of channel failures, and the small safety margins that currently exist with respect to moderator temperature (or moderator subcooling) requirements, CNSC staff requested the validation of the computer code used to calculate the moderator temperature distribution against three-dimensional (3D) integral moderator tests.

The 3D test was completed in December 2001 to the satisfaction of CNSC staff. This was followed by the validation of the computer code MODTURC-CLAS against both separate effect testing and the results of the 3D integral test. This work is carried out by an industry team representing all Canadian utilities. The team meets on a regular basis with CNSC staff to present and discuss code models and code predictions as compared to experimental data.

In December 2004, the industry team requested the closure of this GAI, and submitted a summary report with references describing all work completed on this GAI in draft forms. In 2005, more technical work on related issues was completed, and all reports were issued in their final forms. In 2006, CNSC staff plan to complete the review of reports submitted and make the decision with regard to the request for closure.

GAI 98G01 - Heat Transport System Pump Operation under Two-Phase Flow Conditions

The operation of the primary heat transport system (HTS) pumps under LOCA conditions can be detrimental to the integrity of the system piping due to the generation of large pressure pulsations and excessive pump vibration. In the past, piping analysis was performed using limited experimental information from laboratory tests. This approach was sensitive to the interpretation of the test data and their application to the reactor. Re-assessment was needed to obtain a more realistic representation of the behaviour of the pump and piping under various accident conditions. In particular, the fatigue analysis of the HTS piping required updating with the use of a conservative forcing function.

This GAI had been previously closed for all stations except Bruce A.

In 2005, Bruce Power provided additional analysis as requested by CNSC staff and requested closure of the GAI. The Bruce Power submission recommended reducing the time of automatic pump trip to 10 minutes.

CNSC staff agreed with the Bruce Power position that the recommended action would ensure piping integrity under the most severe conditions resulting from two-phase operation of heat transport pumps. CNSC staff also verified that the reduction in pump trip time did not compromise fuel cooling. On this basis, CNSC staff closed the GAI.

GAI 98G02 - Validation of Computer Programs used in Safety Analysis of Power Reactors

In the past, CNSC staff assessed licensees' computer programs and safety analysis methods, and identified several inadequate practices with respect to computer program validation. Examples of poor practices include lack of a managed process in performing validation, poor documentation of computer program validation, poor applicability of validation due to the limited range of conditions in the validation experiments in comparison with the reactor analysis, and inadequate assessment of the impact of dimensional scaling and important phenomena for which adequate validation data do not exist. CNSC staff concluded that these inadequate practices eroded overall confidence in the safety analyses results.

The industry has responded to this GAI favourably by establishing a quality control process to improve the computer code validation, and by achieving an overall level of baseline validation for a specific set of major computer codes used in safety analyses. These efforts, once confirmed by CNSC staff's reviews and audits of relevant licensees' programs, are considered to be sufficient to warrant the closure of this GAI. This GAI had been closed for Bruce Power, OPG, and most recently for NB Power Nuclear in June 2005. A related audit at Hydro-Québec was carried out in February 2005 with satisfactory results, and the closure of this GAI for Hydro-Québec is planned for the first quarter of 2006.

GAI 99G01 - Quality Assurance of Safety Analysis

The CNSC expects power reactor licensees to conduct operations in accordance with a quality assurance (QA) program. This program includes requirements for various safety-related activities, including safety analyses. The acceptability of the safety-related information established by safety analyses depends on the degree of conservatism incorporated into the analyses. It also relies on the credibility of the analytical tools and activities (such as computer codes, methods and input information). Licensees need to perform safety analyses in a systematic manner, using QA principles, to ensure confidence in the licensing basis and safe operating envelope for each facility.

CNSC staff had become aware of an increasing number of occurrences of poor safety analysis practices by power reactor licensees caused by inadequate QA. These poor practices were identified through audits and assessments. The initiation of this GAI in 1999 was due to the CNSC staff conclusion that inadequate QA of safety analyses had caused a reduction in the overall confidence in the safety analysis results.

The industry has responded by establishing QA frameworks and procedures related to safety analysis, and by taking actions to satisfy all relevant closure criteria. This GAI has been closed for Bruce Power, and is under review for other licensees. The results of the audit at NB Power Nuclear are satisfactory, but the closure of this GAI is contingent on the compatibility of the newly established procedures with the overall QA program being developed at NB Power Nuclear. The results of the audit at OPG are also satisfactory, but CNSC staff has to assess its compatibility with the new QA program following the re-organization of OPG. Relevant audit has been carried out for Hydro-Québec in February 2005 with satisfactory results.

Subject to satisfactory results of the CNSC staff's reviews and relevant audits, CNSC staff is planning to close this GAI, on its own merits, for all licensees in the 2005-2006 fiscal year. The compatibility with the overall QA program, however, will be addressed under a separate action.

GAI 99G02 – Replacement of Reactor Physics Computer Codes used in Safety Analysis of CANDU Reactors

Licensees use reactor physics methods and computer codes to support nuclear design, operation and compliance with the safe operating envelope. There are stringent requirements on accuracy and validation of these methods and codes due to their role in the confirmation of safe operation. Recent experimental data, as well as reviews of key computer codes, identified several shortcomings. These deficiencies are related to inaccurate predictions of key parameters for accident conditions, lack of proper validation and a significant lag of licensees' methods and codes behind the current state of knowledge in this area. These shortcomings had a negative effect on the overall confidence in the results of reactor physics analyses, especially for those analyses where safety margins are small.

Under this GAI, licensees are required to carry out a structured program of replacement of reactor physics computer codes. In February 2001, an industry project to analyze a power pulse following a LLOCA with the new set of reactor physics codes resulted in the prediction of more severe consequences than those presented in earlier licensing submissions. To mitigate the potential effects of this, the licensees implemented more restrictive operating limits, such as flux tilt limit, moderator and coolant purity limits, and moderator poison load limit to compensate the increase in the predicted power pulse. Following imposition of those restrictions, licensees continued their structured programs to replace reactor physics computer codes.

A report of an independent expert panel (see GAI 95G04) assessed the adequacy of estimated uncertainties of certain key parameters predicted by the codes. Two licensees (Bruce Power and OPG) completed an agreed set of activities and declared the new reactor physics toolset in service for future accident analysis. The new reactor physics toolset was applied in licensing safety analysis and commissioning of the Bruce A Units 3 and 4 restart. Work on a second set of activities on code validation has been completed in 2004 and Bruce Power and OPG requested the closure of this GAI. CNSC staff review of OPG and Bruce Power submissions is on progress. The work of NB Power Nuclear and Hydro-Québec is behind schedule. NB Power Nuclear submitted a revised work plan in 2005.

GAI 00G01—Channel Voiding During a Large LOCA

CNSC staff has a concern that the computer codes used for prediction of overpower transients for CANDU reactors with a positive coolant void reactivity coefficient have not been adequately validated. This GAI requires the licensees to carry out direct void fraction measurements, provide an assessment of the scaling of the results to the phenomena expected in the reactor, perform validation exercises using these data and complete an impact assessment on the safety margins.

Tests with void fraction measurements in Atomic Energy of Canada Limited's (AECL) RD-14M facility have been completed, and data analysis reports have been submitted to the CNSC. The industry has provided information on the computer code validation exercises and the scaling assessment.

After reviewing the information submitted by the industry, CNSC staff requested each licensee to provide a plan to:

- perform scaling analysis and document the scaling rationale for the RD-14M simulated LLOCA experiments. As well, demonstrate the relevance of the channel void measurements in these RD-14M experiments to the reactor situation,
- provide estimates of the simulation uncertainty of the system thermalhydraulic code for predicting the channel void fraction during the rapid voiding phase following a LLOCA. The estimates should use the simulation and experimental results for the channel voiding behaviour in the RD-14M LOCA tests,
- provide confirmation that the system thermalhydraulic code, when simulating the channel voiding behaviour during LLOCA, is used in the same way as in the validation exercises. Any deviations in the usage of the computer code in safety analysis are to be identified, explained and justified, and
- perform sensitivity calculations to examine the effect of uncertainties in channel void predictions of the system thermalhydraulic code during the early blowdown phase on key safety parameters (*e.g.*, peak fuel centreline and sheath temperatures) of a LLOCA.

Licensees have responded to the CNSC staff request and provided a plan to address the above issues. A progress update meeting on the ongoing activities under this GAI was held on July 13, 2005. Ongoing discussions between CNSC and industry staff will continue to resolve the outstanding issues.

GAI 01G01 - Fuel Management and Surveillance Software Upgrade

This GAI was initiated as a follow-up to the closure of GAI 95G03. The GAI only relates to Bruce Power and OPG.

Compliance with reactor physics safety limits that define the safe operating envelope, such as channel and bundle power limits, is based on analyses performed with a fuel management computer code. Recent, more rigorous scrutiny of the accuracy of methods, acceptance criteria, assumptions and results of safety analyses of various design basis accidents led to significant restrictions of operating parameters, including channel and bundle powers, and introduction of additional physics parameters for compliance purposes, such as fuel string relocation reactivity and minimum margin to axial constraint. As such, the significance of compliance with safety-related reactor physics limits has increased. This has enhanced the need for an improved analytical model, validated over a broader range of applications and conditions as well as better-defined compliance allowances and more consistent procedures.

To achieve closure of this GAI, licensees were required to undertake a structured program for reactor core surveillance that covers the fuel management software upgrade and validation as well as validation and qualification of the error compliance methodology.

Commensurate progress has been made so far. Bruce Power and OPG submitted detailed work plans and schedules, as well as semi-annual progress reports. Work is divided into two main phases. Phase I deals with modeling improvements to the SORO computer code and Phase II deals with estimation of error allowances.

A significant milestone was achieved in December 2003 with the implementation of a first-improved version of the computer code WIMS-IST-SORO. Significant progress has been made during 2005 with the completion of work related to validation of WIMS-SORO version against flux measurements in a CANDU 6 reactor. CNSC staff is closely monitoring the progress of this GAI.

APPENDIX F

FRENCH TRANSLATION OF SECTION 1.5

1.5 GENTILLY-2

1.5.1 Exploitation

Site	DOMAINE DE SÛRETÉ Programme	Cotes Programme	 Mise en oeuvre
Gentilly-2	EXPLOITATION	B	B
	Gestion de l'organisation et de la centrale	B	B
	Conduite des opérations	B	B
	Santé et sécurité au travail (non radiologique)	B	B

Le domaine de sûreté « exploitation » à Gentilly-2 répondait aux attentes du personnel de la *Commission* canadienne de la sûreté nucléaire (CCSN) tant de l'aspect programme que mise en œuvre. Les programmes de ce domaine de sûreté ont contribué de façon adéquate à l'exploitation sûre de la centrale en 2005 et, en général, à la réalisation des résultats que vise la CCSN. Bien que la centrale de Gentilly-2 ait été exploitée de manière sûre en 2005, on a observé une certaine dégradation dont Hydro-Québec devrait s'occuper sans tarder.

1.5.1.1 Gestion de l'organisation et de la centrale

Il n'y a pas eu de *défaillances graves de système fonctionnel* à Gentilly-2 en 2005. Les systèmes de sûreté ont réagi tel que conçus lors des trois transitoires qui se sont produits : un déclenchement du réacteur (précédé d'un *recul rapide de puissance*), un *recul rapide de puissance* et une *baisse contrôlée de puissance* (voir le tableau 1). La *baisse contrôlée de puissance* en 2005 et le *recul rapide de puissance* en 2004 étaient liés à des problèmes de gestion de la configuration. Le personnel de la CCSN considère qu'il est important de rectifier ces problèmes en temps opportun afin de maintenir une défense en profondeur.

Les processus de gestion d'Hydro-Québec étaient conformes aux normes applicables et des programmes portant sur la tenue des lieux et l'exclusion des corps étrangers étaient en vigueur. On a fait face à certaines difficultés lors de la mise en œuvre de ces programmes en 2005. Cependant, il y a eu des progrès comparativement au rendement antérieur et le personnel de la CCSN fait un suivi auprès d'Hydro-Québec.

On a observé, au début de 2005, qu'Hydro-Québec n'avait pas effectué et documenté quelques auto-évaluations requises et qui constituent des activités de surveillance clées servant à s'assurer que le titulaire de permis remplit efficacement ses responsabilités en matière de sûreté. Ceci est aussi abordé à la section 1.5.2.1.

Le programme d'information du public et les garanties liées au déclassement répondaient aux exigences de la CCSN en 2005.

1.5.1.2 Conduite des opérations

Les programmes portant sur le respect des procédures, les communications, le contrôle des changements, la gestion des arrêts et l'accréditation des opérateurs n'ont pas été évalués formellement en 2005 mais ils sont toujours considéré satisfaisants.

Le respect des procédures a constitué un problème dans plusieurs domaines en 2005. Hydro-Québec a effectué des changements considérables au domaine « radioprotection » qui, une fois pleinement mis en œuvre, devraient apporter une amélioration importante.

Plusieurs incidents mettant en cause des vannes mal positionnées ont été observés en 2005. On a aussi noté que le processus de contrôle de la documentation d'Hydro-Québec comportait des anomalies, particulièrement en ce qui a trait à la mise à jour de l'information et le contrôle des révisions de documents. Le personnel de la CCSN effectue un suivi auprès d'Hydro-Québec sur chacun de ces points.

Les pratiques opérationnelles observées lors de l'arrêt en 2005 ont révélé un rendement faible dans un nombre de domaines incluant l'alignement des systèmes (gestion de la configuration), la protection contre l'incendie, l'exclusion des corps étrangers, et la protection des travailleurs. Des incidents liés au nettoyage des générateurs de vapeur (GV) effectué lors de l'arrêt sont décrits à la section D.6.2. Hydro-Québec a mis en œuvre plusieurs initiatives afin d'améliorer le rendement lors des arrêts. Avant le redémarrage, le personnel de la CCSN a effectué une inspection spéciale axée sur l'alignement des systèmes et l'exclusion des corps étrangers. Cette inspection a démontré qu'Hydro-Québec avait mis en place des mesures suffisamment adéquates pour permettre le redémarrage. Des inspections effectuées ultérieurement par le personnel de la CCSN n'ont pas révélé d'autres problèmes.

1.5.1.3 Santé et sécurité au travail (non radiologique)

La valeur de l'indicateur de rendement « taux de gravité des accidents » à Gentilly-2 (3.6 en 2005) était légèrement supérieure à la valeur pour l'ensemble de l'industrie (voir les tableaux 9 et 10). Cette valeur était aussi légèrement supérieure à celle de 2004 (1.2) mais demeure considérablement plus basse qu'au cours des trois années précédentes (voir le tableau 11). Globalement, le programme « Santé et sécurité au travail (non radiologique) » et sa mise en ouvre répondaient aux attentes de rendement de la CCSN.

1.5.2 Assurance du rendement

Site	DOMAINE DE SÛRETÉ Programme	Cotes Programme	 Mise en oeuvre
Gentilly-2	ASSURANCE DU RENDEMENT	B	C
	Gestion de la qualité	B	C
	Facteurs humains	B	C
	Formation, examen et accréditation	B	C

La mise en œuvre du domaine de sûreté « assurance du rendement » présente des faiblesses qui amoindrissaient la contribution de ce domaine de sûreté à la défense en profondeur globale à Gentilly-2.

1.5.2.1 Gestion de la qualité

Des suivis et inspections effectués à Gentilly-2 en 2005 ont démontré qu'il existait des lacunes dans la mise en œuvre du programme « gestion de la qualité ». Hydro-Québec n'a pas fourni de preuves pouvant démontrer que les résultats du processus d'auto-évaluation par la direction étaient mis en œuvre efficacement. De plus, des inspections ont démontré qu'Hydro-Québec éprouvait des difficultés en ce qui concerne le respect des procédures, le contrôle des documents, la conservation des registres, la mise en œuvre d'un processus d'évaluation du rendement des fournisseurs, et l'efficacité du processus de mesures correctives.

1.5.2.2 Facteurs humains

En se fondant sur les activités de conformité effectuées en 2005, le programme « facteurs humains » à Gentilly-2 répondait aux attentes de la CCSN et des améliorations ont été apportées à la mise en œuvre d'éléments des programmes « facteurs humains » et rendement humain. Cependant, la mise en œuvre du programme rendement humain demeurait inférieure aux attentes.

Hydro-Québec a mis de l'avant un nombre d'initiatives pour améliorer le rendement humain. Cependant, on a tardé à donner suite à des recommandations découlant d'analyses d'incidents effectuées à l'interne. De plus, des inquiétudes ont été soulevées au sujet de lacunes du rendement humain, incluant un manque de prudence dans la prise de décisions. Le titulaire de permis a pris des mesures pour s'attaquer à plusieurs des problèmes et des activités additionnelles d'application de la réglementation seront effectuées pour confirmer l'efficacité de ces initiatives.

Gentilly-2 a élaboré un processus pour intégrer les facteurs humains au processus de contrôle des modifications techniques et l'a utilisé dans le cadre d'un projet de construction d'une installation d'entreposage de déchets radioactifs solides. La présentation du titulaire de permis répondait aux attentes du personnel de la CCSN.

En 2005, Gentilly-2 a soumis un rapport portant sur l'auto-évaluation de la culture de sûreté qu'elle avait effectuée en 2004 et qui avait permis d'identifier des points positifs (ex. l'usage fait de l’expérience d’exploitation, les communications, etc…), ainsi que d’autres nécessitant des améliorations.

1.5.2.3 Formation, examen et accréditation

Aucune évaluation des programmes de formation du personnel accrédité et du personnel non accrédité, de même que du programme d’examens de requalification, n’a été effectuée à Gentilly-2 en 2005. De plus, aucun examen d’accréditation n’a eu lieu.

Tel que demandé par la CCSN, Gentilly-2 a soumis un plan de mesures correctives pour régler les lacunes identifiées lors des évaluations du programme de formation initial du personnel accrédité effectuées en 2003 et 2004. En décembre 2005, le personnel de la CCSN effectuait une évaluation de ce plan. Bien que Gentilly-2 n’ait pas encore effectué une analyse formelle du travail et des tâches des opérateurs de salle de commande, il est présentement prévu qu’une telle analyse sera complétée en 2006. Hydro-Québec a demandé de clore plusieurs avis d’action soulevés à la suite des deux dernières évaluations de la CCSN.

En général, Gentilly-2 réalise des progrès appréciables quant au respect de ses engagements au sujet des actions correctives encore à compléter relativement aux programmes de formation pour le personnel accrédité et non accrédité. Cependant, la mise en œuvre du programme « formation, examen et accréditation » est toujours inférieure aux exigences.

1.5.3 Conception et analyse

Site	DOMAINE DE SÛRETÉ Programme	Cotes Programme	 Mise en oeuvre
Gentilly-2	CONCEPTION ET ANALYSE	B	B
	Analyse de sûreté	B	B
	Questions de sûreté	B	B
	Conception	B	B

Le domaine de sûreté « conception et analyse » à Gentilly-2 répondait aux attentes du personnel de la CCSN tant de l’aspect programme que mise en oeuvre. Les programmes de ce domaine de sûreté ont contribué adéquatement à l’exploitation sûre de la centrale en 2005 et à la réalisation des résultats que vise la CCSN. Les examens effectués par le personnel de la CCSN ont permis de conclure que les analyses de sûreté effectuées par le titulaire de permis et ses réponses aux nouvelles questions de conception et de sûreté continuent d’être acceptables.

1.5.3.1 Analyse de sûreté

Les examens effectués par le personnel de la CCSN ont confirmé qu’en 2005 Hydro-Québec a effectué des analyses de sûreté acceptables et qu’une mise à jour de son rapport de sûreté est en cours. Le financement octroyé par Hydro-Québec aux programmes de recherche de même que la surveillance et l’évaluation qu’elle fait des nouvelles informations et des résultats de recherche, afin de s’assurer de la justesse de l’analyse de sûreté, étaient tous deux satisfaisants.

1.5.3.2 Questions de sûreté

Le personnel de la CCSN a évalué le progrès réalisé par les différentes équipes du secteur nucléaire pour régler les dossiers génériques (DG). Hydro-Québec a continué de participer à ces équipes et le progrès global réalisé était satisfaisant. Pour plus d'information sur des questions spécifiques de sûreté, se référer à l'annexe E.

1.5.3.3 Conception

En 2005, une vérification interne d'Hydro-Québec a révélé que son programme d'évaluation du rendement des fournisseurs comportait plusieurs lacunes. Par exemple, les registres des évaluations des fournisseurs et une liste approuvée de fournisseurs n'étaient pas mis à jour. De plus, la mise en œuvre de la procédure de suivi des évaluations du rendement des fournisseurs n'était pas prête.

En 2005, le personnel de la CCSN a évalué certains éléments de la mise en oeuvre du programme de la protection contre l'incendie de la centrale. Les examens et évaluations de rapports de faits saillants et des éléments du programme n'ont pas révélé de lacunes importantes de sa mise en œuvre (à l'exception des lacunes de la protection contre l'incendie observées au cours de l'arrêt en 2005).

Globalement, le programme « conception » de Gentilly-2 et sa mise en œuvre répondaient aux attentes de la CCSN.

1.5.4 Aptitude fonctionnelle de l'équipement

Site	DOMAINE DE SÛRETÉ Programme	Cotes	
		Programme	Mise en oeuvre
Gentilly-2	APTITUDE FONCTIONNELLE DE L'ÉQUIPEMENT	B	B
	Entretien	B	B
	Intégrité structurale	B	B
	Fiabilité	B	B
	Qualification de l'équipement	B	B

Le domaine de sûreté « aptitude fonctionnelle de l'équipement » à Gentilly-2 répondait aux attentes du personnel de la CCSN tant de l'aspect programme que mise en oeuvre. Les programmes de ce domaine de sûreté ont contribué à l'exploitation sûre de la centrale en 2005 et à la réalisation des résultats que vise la CCSN.

1.5.4.1 Entretien

Gentilly-2 est dotée de politiques, processus et procédures qui procurent direction et appui à son programme d'entretien. Hydro-Québec a introduit un nouveau modèle de processus d'un système de gestion de la qualité qui comprend les processus de base et les processus de niveaux inférieurs qui sont conçus de façon à répondre aux besoins de son programme d'entretien. Une organisation importante avec des buts bien établis soutient ce programme.

1.5.4.2 Intégrité structurale

Une évaluation du programme d'inspections périodiques de Gentilly-2 effectuée par le personnel de la CCSN a révélé que plus de 200 inspections prévues en 2002, 2003, 2004 et 2005 n'avaient pas été effectuées.

En prévision d'une inspection en cours de fonctionnement en avril 2005, un nouvel ensemble de modèles de prévision par ordinateurs a été utilisé pour dresser une liste des canaux de combustible dont l'emplacement des patins d'espacement devait être déterminé afin de les repositionner au besoin (manœuvre SLAR). Les premiers résultats pour un canal indiquaient que la marge de temps avant qu'un contact tube de force - tube de calandre ne se produise, et la formation subséquente d'une ampoule causée par les hydrures, était considérablement plus courte que celle jugée acceptable par le personnel de la CCSN. Hydro-Québec a effectué un arrêt forcé en décembre 2004 et une manœuvre SLAR sur le canal en question ainsi que sur trois autres canaux pour lesquels un contact était prévu avant le début des travaux de prolongation de la durée de vie utile. Hydro-Québec a informé le personnel de la CCSN qu'il n'y aurait pas de contacts dans les quatre canaux jusqu'à bien après la date prévue du début des travaux de prolongation de la durée de vie utile. Pour plus d'information, voir la section D.6.1.

Une "anomalie" a été décelée sur une soudure d'un raccord d'un tuyau d'alimentation lors d'inspections de ces tuyaux en mai 2005. Hydro-Québec attribuait cette anomalie à un défaut de la soudure par fusion et non à une fissure induite en cours de fonctionnement. Hydro-Québec a soumis une étude de l'aptitude fonctionnelle continue de ce tuyau d'alimentation qui incluait une analyse de croissance induite par la fatigue et une analyse de stabilité de la fissure. Hydro-Québec en a conclu que l'état du tuyau d'alimentation était bon pour une période de service d'au moins deux ans. Le personnel de la CCSN a approuvé les dispositions prises au sujet de l'anomalie et recommandé que la soudure du tuyau d'alimentation soit inspectée à nouveau lors de la prochaine inspection afin de confirmer ses caractéristiques et déceler tout changement imprévu de sa grosseur.

1.5.4.3 Fiabilité

Hydro-Québec a continué à prendre des mesures pour se conformer aux exigences de la nouvelle norme d'application de la réglementation S-98 (Programmes de fiabilité pour les centrales nucléaires). Les plans de conformité ont été élaborés conformément à l'approche globale adoptée par l'industrie.

La capacité de fonctionner tel que conçu des systèmes importants pour la sûreté répondait aux exigences réglementaires en 2005.

1.5.4.4 Qualification de l'équipement

En 2004, Hydro-Québec a identifié un nombre de mesures correctives devant être prises afin de démontrer que Gentilly-2 se conformait à la condition de son permis d'exploitation portant sur la *qualification environnementale* et aux critères d'acception connexes. Au cours de 2005, Hydro-Québec a soumis un nombre de rapports techniques au sujet de ces mesures. Le personnel de la CCSN a étudié la plupart de ces rapports et conclu qu'Hydro-Québec a fait des progrès appréciables pour résoudre les problèmes en suspens. Cependant, afin de compléter les mesures correctives requises, Hydro-Québec produira encore plusieurs documents et effectuera des modifications en chantier.

1.5.5 Préparation aux situations d'urgence

Site	DOMAINE DE SÛRETÉ	Cotes	
		Programme	Mise en oeuvre
Gentilly-2	PRÉPARATION AUX SITUATIONS D'URGENCE	A	B

La réaction d'Hydro-Québec lors d'un incident au cours duquel deux travailleurs ont inhalé de l'ammoniaque (voir section D.6.2) a été jugée satisfaisante.

Le personnel de la CCSN a effectué un suivi, sous forme d'une *inspection de type II*, d'un exercice d'urgence mettant en cause le chlore, tenu à Gentilly-2 en 2005. L'équipe d'inspection a conclu que, même si Gentilly-2 démontre toujours pouvoir gérer efficacement ses interventions en cas d'urgences radiologiques ou nucléaires, il existait quelques points faibles dans la gestion des urgences au chlore. Hydro-Québec a déjà pris des mesures correctives pour éliminer les lacunes ayant trait à cet aspect de ses mesures d'urgence. Il n'y avait aucune indication d'écarts majeurs par rapport aux attentes en matière de rendement de la CCSN.

Au cours de la visite au site de Gentilly-2, l'équipe d'inspection a aussi conclu qu'il n'y avait pas de signes laissant supposer une dégradation du programme « préparation aux situations d'urgence » même. Tous les problèmes que la CCSN a soulevés au cours d'inspections antérieures ont été réglés ou sont en voie de l'être, sans qu'il n'y ait d'effets adverses sur le maintien de la capacité d'intervenir en cas d'urgence et l'efficacité de telles interventions. Par conséquent, le programme continue d'excéder les attentes.

1.5.6 Protection de l'environnement

Site	DOMAINE DE SÛRETÉ	Cotes	
		Programme	Mise en oeuvre
Gentilly-2	PROTECTION DE L'ENVIRONNEMENT	B	B

Le domaine de sûreté « protection de l'environnement » à Gentilly-2 répondait aux attentes de la CCSN tant de l'aspect programme que mise en œuvre. Les rejets atmosphériques et liquides de substances radioactives à Gentilly-2 étaient inférieurs aux *limites opérationnelles dérivées*. Par conséquent, les doses estimées de rayonnement à la population étaient bien inférieures aux limites réglementaires. Il n’y a pas eu en 2005 à Gentilly-2 de rejets imprévus de substances radioactives ou dangereuses pouvant présenter un risque inacceptable pour l’environnement.

1.5.7 Radioprotection

Site	DOMAINE DE SÛRETÉ	Cotes	
		Programme	Mise en oeuvre
Gentilly-2	RADIOPROTECTION	B	B

En 2004 et 2005, Hydro-Québec a mis en oeuvre plusieurs initiatives relatives au programme « radioprotection » afin de régler des problèmes qui persistaient. En 2005, le personnel de la CCSN a fait un suivi à Gentilly-2 portant une attention accrue sur les *points à régler* suite à l’*inspection de type I* effectuée en 2004 et aux *inspections de type II* qui y ont fait suite. En se fondant sur des examens de documents, des observations, et des échanges d’information avec le personnel d’Hydro-Québec, le personnel de la CCSN a conclu que la mise en œuvre de la radioprotection répond maintenant aux attentes de la CCSN.

1.5.8 Sécurité des sites

L’évaluation du domaine de sûreté « sécurité des sites » à Gentilly-2 est documentée dans un rapport séparé (secret) (CMD 06-M35.A).

1.5.9 Garanties

Site	DOMAINE DE SÛRETÉ	Cotes	
		Programme	Mise en oeuvre
Gentilly-2	GARANTIES	B	B

Les programmes en vigueur à Gentilly-2 en 2005 pour aider à s’acquitter des obligations du Canada relativement aux *garanties* internationales répondaient aux exigences réglementaires applicables et aux attentes du personnel de la CCSN.